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CANTOR LECTURES

ON

STEREOTYPING.

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BY

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SYLLABUS.

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STEREOTYPING.

BY

THOMAS BOLAS, F.C.S., F.I.C.

LECTURE I.—DELIVERED FEBRUARY 17, 1890.

HISTORICAL NOTES AND GENERAL CONSIDERATIONS.

The notion of casting from the assemblage of types, known to the printer as his "forme," seems to be nearly as old as the art of printing from movable types, a thing easily understood when one remembers that the art of fine casting in copper alloys was well understood four centuries ago, and the advantage of a solid page, not subject to fresh errors at the hands of every careless workman, must have been very obvious to those early printers, who tried so hard to eliminate errors of the Press. Indeed, as regards the early history of stereotyping (in a copper alloy, such as brass or bronze) we may go back to the work of a Chinese stereotyper, who according to Skeen* laboured very successfully about the year 1041.

The incentive to stereotyping in the early days does not appear to have been so much the multiplication of "formes," for the rapid production of copies, or the saving of type—for the old printers had very large founts—but the notion that mainly set the matter going seems to have been the desire to secure that accuracy of all copies which can never be depended upon when movable types are used for printing.

Accordingly we find that one of the first considerable use of brass stereotype plates was for tabular matter, Gabriel Valleyre, a printer of Paris, having produced numerous calendar plates about the year 1700, the brass being cast in clay or loam moulds. Valleyre's plates were small—about such size as one would use for foolscap octavo pages—and the sharpness of the letters was very much inferior to that of the type pages printed alongside. Still the brass plates answered their purpose to a certain extent, but the want of sharpness of such casts, and the difficulty of making large plates, were sources of trouble to a clergyman of Leyden, Jean Muller, who with his son William, was endeavouring about this time to produce stereotype editions of the Scriptures (1700-1711). After numerous experiments in brass casting, this gentleman adopted the plan of producing solid pages, first by cementing the types together, and afterwards by melting the types together at the feet; this latter process being a very easy one if the "forme" is locked up so as to be thoroughly framed with the wooden furniture, and is placed on an iron surface which can be gradually heated to something short of redness. Muller was an enthusiast in his work, and he produced in this way a Syriac New Testament, a Greek Testament, and a Dutch folio Bible. This latter work was reprinted from his blocks as late as 1791 by Elwe, of Amsterdam, and some of his solid pages are in existence at the present time.*

The process of casting plates of type-metal in plaster moulds appears to have originated with a goldsmith and money-lender of Edinburgh, William Ged (1725), who was moved to experiment by a conversation with a printer, who told him a fortune would be the result of success in casting from the "forme." In a few days Ged managed to produce ex-

* William Skeen, "Early Typography." Colombo (Ceylon), 1872.

* With a view of ensuring accuracy, Firmin Didot, in 1794, issued logarithmic tables in what he termed "stereotype;" but in this case the types were merely cemented together in order that there might be no risk of introducing errors in working from them or in handling them. More recently, Charles Babbage (1827) took advantage of stereotyping to ensure greater certainty in tabular work, his tables of logarithms having been stereotyped before the final proofs were read, and the corrections were made by cutting out the false figures and soldering in the necessary types, a proceeding which eliminated the old difficulty that, in making corrections, fresh errors were so often introduced. Corrections in these plates have been made from time to time, and an edition was printed last year by Messrs. Spon and Co.

cellent casts, and set about looking out for the fortune which was to be the result. Ged and his sons seem to have spent most of their efforts, during a period of about half a century, in getting fresh partners, and in quarrelling over financial matters, with the result that they got no profit out of the transactions; but during this time many persons got hints as to their method of working, and the plaster process was experimented with in various parts of Great Britain. During this period (1740) Michel Funckter, a printer, of Erfurth, stereotyped by the plaster process. He made a paste by mixing—

Plaster of paris	5 parts
Crushed brick	2 ,,
Asbestos	1 ,,
Water enough to make a paste	

This was spread on a slab, and the type "forme" was pressed into it, and when the mould thus obtained was dry, the type metal was poured into it. Funckter published details of his method in the form of a pamphlet, but Ged—who seems to have worked in a very similar way, *i.e.*, by forcing the face of the forme against a soft bed of plaster, and not by pouring the mixed plaster over the forme—endeavoured to keep his process secret.

Funckter also described methods of casting type metal in sand moulds, the sand being bonded by linen or woollen fibres, and by the use of beer for mixing. To Funckter belongs the credit of giving the plaster process of stereotyping openly to the world, and there is no record of the time when he commenced his experiments, or whether he knew of Ged's work.

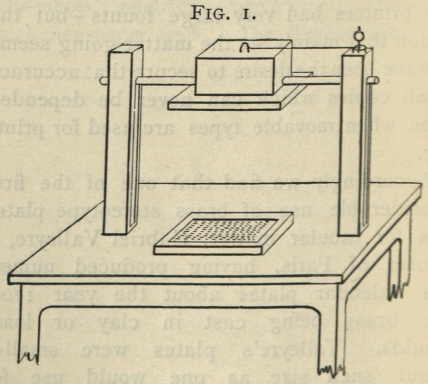
The introduction of D'Arcet's fusible alloy, 1773—an alloy composed of bismuth, 8 parts; lead, 5 parts; and tin, 3 parts, and which melts below the heat of boiling water—was looked upon in Paris as likely to be of great service in stereotyping, but little was done with it beyond some experimental work.

About this time stereotyping was an established process, and was in regular use in several of the larger printing offices, especially on the Continent, and we find several persons publishing working details, notably Joseph Hoffman, who made moulds of plaster and clay, tempered with gelatine, gum, or starch (1783), while Andrew Foulis, of Glasgow (1784), was casting plates regularly, with the co-operation of Alexander Tilloch, of the same place. The stereotype books of Foulis are well known, and need no mention here.

Stereotyping methods were extensively employed in reproducing the credit notes or *assignats* of the Revolution period in France, it having been found impossible to prevent forgery while the designs on the authorised notes of the same denomination varied, and when engraved by hand they were found to vary in spite of every care. It was not, however, till 1797 that Gatteaux, who had charge of the printing of the *assignats*, got the stereotyping arrangements of the national printing office in good working order, and the method he adopted was one perfected by the celebrated printer, Firmin Didot, although originated some few years previously by Joseph Carez, a printer of Toul.

According to this method, to which the name "Polytype" was frequently applied, the page of type, or the original to be copied, is slightly oiled, and fixed face downwards on a block of wood, supported, at some little distance over a paper or cardboard tray, into which melted type-metal has been poured. Just as the type-metal begins to show distinct signs of solidification, the block carrying the page of type is allowed to fall on the soft metal, and on separating the two a reverse, or mould, is obtained. This reverse, or mould, being now fixed upon the lower face of the drop-block, is allowed in its turn to fall on the surface of type-metal contained in a paper tray, this metal being at the point of solidification as before. The paper tray is of course crushed in each case, and to regulate the thickness of the "strike," metal gauges are fixed alongside the paper tray, and in such position that the frame or chase containing the original, when down, shall rest upon them.

FIG. 1.



DIDOT'S POLYTYPE APPARATUS.

I will show you how easy it is to illustrate this method by means of an ordinary stamping press provided with a quick screw, but the diagram before you (Fig. 1) will give you an

idea of a simple form of apparatus originally used, and which was constructed of hard wood. The arrangement of parts is sufficiently obvious without further explanation, excepting that it may be mentioned that the rod carrying the catch which releases the block should stretch from one standard to the other, the catch being taken out of the staple in the drop-block by putting the wire in torsion. This process is still in occasional use for the rapid reproduction of small typographic ornaments or blocks, but in such cases the matrix is generally a thick electrotype cast made from the original block. For initial letters or ornaments about an inch and a half square, there is probably no quicker or better method of reproduction than that of striking the matrix into semi-fluid type-metal.

At another period Firmin Didot adopted the plan of forcing the forme of type by dead pressure against a sheet of soft lead, and the matrix or reverse thus obtained served for obtaining printing plates by the method of striking into semi-fluid type-metal just described. I will show you how easy it is to obtain a reverse in soft sheet-lead by dead pressure, and also that if the lead matrix is placed in the ordinary stereotype casting-box, casts may be obtained from it in ordinary type or stereotype metal, these alloys melting at a lower temperature than the lead. In a similar way a lead matrix may be made by driving an ordinary type punch-ways into a piece of lead, and the lead matrix being adjusted to an ordinary hand-mould of the right body size, it is easy to cast a number of types in it, which are about as good as the original; this being often a very convenient process to follow when a few extra types are wanted in a hurry.

In the usual casting operations it is generally necessary that the mould in which the casting is made should be of less fusibility than the material cast, although there are rare cases in which this does not hold good; but in the case of the striking method just described, we have a method by which an impression may be obtained in a much more refractory material than the original matrix. For example, an impression in sealing wax taken from type may be quickly driven down on the surface of type-metal just on the point of commencing to solidify, and will yield a perfect cast in the alloy, and this I illustrate very easily by means of the quick screw-press before used. Similarly, a die in high steel may be made from a silver or copper coin, if the steel is heated to bright whiteness, and the coin, attached to a drop-hammer, is allowed to fall upon it. The main points to ensure success appear to be forming of the steel block as a blunt cone, so that the middle shall first come in contact with the original, and the protection of the hot steel from the action of the air till the last instant. I have seen dies made by this process at the works of the Phœnix Die Company, of Princes-street, Blackfriars, so perfect as to recall the smoothness and perfection of an electrotype, and I was told it was no uncommon thing for mints to send coins in order to obtain fresh dies for the replacing of injured ones. The method of moulding by striking into soft metal is of great interest, and those interested in methods of typographic reproduction should bear in mind the possibilities of this method. If, for example, numerous small stereotypes in hardened steel were required, they could readily be obtained by the "striking" method, a steel die (itself, let us suppose, "struck" from an electrotype) being used.

Very much of interest and importance arose out of experiments carried on in the office of Firmin Didot, in Paris, about the end of the last century and the beginning of this. In the first place, the introduction of a hard type-metal containing copper, this being due to Herhan, at the time a workman in the employment of Didot, and the hard metal was introduced to enable the type to stand the strain of moulding by dead pressure against lead plates.

One of Herhan's alloys contained:—Lead, 25 parts; antimony, 15 parts; copper, 6 parts.

Another notable outcome of the work in Didot's office was the production of a matrix by punching the letters into it successively, a device of Guillot, another workman in the service of Didot. Guillot called his process "Graphitype," and he drove the steel type-punches successively into a copper plate, this plate being then used as a matrix for casting a stereotype. Guillot's method may be regarded not only as the parent of the various "type writer" methods of making matrix sheets or strips, but also of Herhan's next introduction—the use of matrix types.

It is easy enough to illustrate to you the principle of Guillot's "Graphitype" by driving these punches into the face of this copper plate, using a guide rule to keep the line, and then casting from the plate in the usual casting-box. In this form, however, it is hardly a practicable method, but its modern developments, in which a kind of type-writer

is used to make a matrix out of wood (the end of the grain) or soft paper, may perhaps come into general use.

Herhan, whose hard metal has just been referred to, developed the idea of his fellow workman, and made it more practicable by setting up the page with matrix types instead of driving the punches into a plate of copper, this arrangement allowing corrections to be made, and also ensuring that the whole of the printing surface shall be in one plane. Herhan's types were of brass or copper, and generally similar to the ordinary types, but in place of the projecting or male letter of our ordinary type, was a female or matrix letter, just the reverse of the face of the usual type. Such letters, a few of which I have made and will hand round, are set just as ordinary types, excepting that they are arranged in the stick and chase non-reversed, and a proof can be taken on the press ; preferably, however, on thin paper, such as is used for copying letters, as the impression must be read through the paper if it is to be read non-reversed. Another way of taking a proof is to lay a sheet of plain paper on the "forme," and over this a sheet of black manifold paper, the coating of which sets off on the plain paper when the pressure is applied. The "forme" being locked up, and any large whites overlaid with special quadrats (or high quadrats may be used in the first instance) it is shut up in a casting-box, and the stereotype is made directly from it. Some of Herhan's matrix forms and casts were recently in the *Conservatoire des Arts et Metiers* at Paris, and are probably still there. Didot issued several books printed from stereotypes made by this method.

The "Linotype" system of Mergenthaler, in which a very cleverly designed machine brings a number of matrices into a row, so that a line is cast, may be regarded as in some sense a development of the idea of Herhan, and before you are specimens illustrating the "Linotype" method, for which I am indebted to Mr. Thomason, the Secretary of the Linotype Company.

Considering that in the case of newspaper work printing is always done from stereotypes, it seems to me that it would be a more reasonable and direct proceeding to set the matrices, and cast the required plate directly into the matrix forme, rather than to delay matters by the intermediate process of moulding. Although Herhan devised excellent methods of striking his matrix type quickly, and in true register, from the original punches; an engineer of the present day could do better: he could design a machine which would turn out brass or copper matrix types about as quickly as wire nails are cut off and headed, and the cost per pound of the matrix type possibly might not exceed that of ordinary types. Again, it is quite easy to make the matrix types radial, so that they can be "made up" in curved boxes, and plates for rotary machines cast as soon as the last lines are set or the final corrections made. On the table are a few radial matrix types which I have made. I cannot help thinking that the time is not far distant when Herhan's matrix type will largely replace those used now, and it need scarcely be said that the ordinary type-setting and distributing machines would be as available with these as with the sort of type now in use. It certainly seems absurd to set a "forme," and mould a matrix from it when it is just as easy to set up the matrix, and to cast directly into it.

Just at the beginning of this century we find A. G. Camus publishing a book on the methods of stereotyping, M. Camus being at that time reponsible director of the printing of the French national currency, and he was required to be present whenever work incident to the production of notes was in progress. This work* gives very interesting details regarding the earlier stereotyping methods.

During the first decade of the present century, several English printing offices, including the two University presses, adopted stereotyping, and self-called "inventors of the process" went about, offering to sell or divulge the process for various sums from £20 upwards. But in 1809, Charles Brightly, of Bungay, in Suffolk, published an English book giving full working details of the plaster process, the method described being practically the plaster process of the present time.† The plaster process of stereotyping was now established, and soon came into very general use for certain classes of work, and the next great step was the paper process, in which softened paper is forced down upon the original type "forme," and in the mould thus obtained one cast or more can be made.

In 1822, De Paroy, of Paris, published a small book‡ describing in short form the lead-

* A. G. Camus. "Histoire et Procédé du Polytypage et de la Stereotypie." Paris: Baudouin, An X. (1801.)

† "The Method of Founding Stereotype," by Charles Brightly. Bungay: 1809. Printed for Charles Brightly by R. Phillips.

‡ "Précis sur la Stéréotypie." Par De Paroy. Paris, 1822. Imprimerie Stereotype de Cosson.

ing stereotype methods, and calling attention to his own improved method, which method was not described, but only its advantages alluded to. It fact, this little book was evidently intended as an advertisement of the author's new and secret process of stereotyping, and from what he says about it, one may pretty confidently suppose it to have been the paper mould process, but in the absence of definite information, it would hardly be the thing to credit De Paroy with the invention of the paper process. We find, however, the method fully developed in a French patent by Genoud, of Lyons, in 1829, but there were certainly several persons making use of it before this time, and since then it has become essentially the stereotyping method, and has ousted all other processes, except for special work. Among other things it has rendered possible the modern newspaper, and the facility which it affords for rapidly producing any required number of curved plates, suited for rotary machines, has revolutionised printing as far as rapid production is concerned.

Moreover, the process is so simple and so easy that any person may, for a cost of a few shillings, produce small stereotype plates equal in sharpness and general excellence with those made in the most perfectly fitted establishment.

At this point my historical sketch is brought to a close, as what is to be said about the origin of later or less important processes may be left over till the methods themselves are described; but I purpose, in this lecture, demonstrating the essential principles of the paper mould method, leaving details until next week.

Here is a pad of soft paper—it is built up of about twenty thicknesses of soft blotting-paper—stapled together at the edges, and a hard impression from a page of type is taken upon this pad. It is now placed between two slabs of dry wood, which slabs are separated, to a distance of something under a quarter of an inch, by strips of the same material, and melted type-metal is poured in at the top. On separating the slabs of wood, you see we have a fairly good cast of the original type, and the whole process of producing it has taken less than a minute. In practice, however, dry paper is not used for making the mould, but a number of sheets of paper are pasted together, and this combination is used damp.

Here are some sheets of paper—of the sorts and quality I will speak next week—and I paste them together with this soft paste. Here, on the other hand, is the soft pasteboard ready made (it is known to the workman as "flong*"), and having laid it on a warm and slightly oiled page of type, I beat the back with a stiff brush until the soft pasteboard has taken a perfect impression of the face of the type. On the back I now lay a piece of blanket, pinch the whole in a screw-press, the press having been previously warmed. The drying of the mould may under such circumstances take from a few minutes to half an hour, according to the temperature and the frequency with which the blanket or other packing is changed; but I have here a similar "forme" upon which is a mould already dry and warm. This being clamped between slabs of warm iron, metal is poured in, and a cast is obtained little if at all inferior to the original type in sharpness. Here, then, you have the essential features of the paper-mould process, and the next lecture will be occupied with the details of this the most important of all stereotyping processes.

In the room there are numerous specimens illustrating stereotyping processes generally, and more especially the paper process; also apparatus and plant. Many of these things have been lent by leading firms; and although special reference to most of them belongs rather to the following lectures than to this evening's subject, I will mention some of them now, and at the same time trust to the kindness of the lenders to allow them remain for the illustration of the subsequent lectures. Messrs. Richardson, Koolman, and Isger send a very extensive collection, which illustrates almost every branch of the work they carry out, and among the casts which they send is a curved stereotype of the special edition of the *Evening Standard* of to-day. Mr. James Dellagana, whose father was, I believe, the first to introduce the paper-mould process into this country, sends a set of specimens illustrating the various stages of this method of stereotyping. Similarly, Mr. Plummer sends illustrative specimens of several processes.

Among the apparatus for stereotyping, the very complete and compact plant of Messrs. Harrild and Sons deserves special notice, also the portable foundry of Messrs. J. M. Powell and Son.

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* In French stereotyping shops the form of the word is "flan," flan being a thin farinaceous cake sold in Paris. The origin of the word would have been less obscured if we had retained the French spelling, and pronounced the word according to the English usage.

LECTURE II.—DELIVERED FEBRUARY 24, 1890.

WORKING DETAILS OF THE PAPER-MOULD PROCESS.

This method—the details of which form the subject for this evening—is essentially the important stereotyping process of our time, and it therefore well merits a whole lecture, especially as at present workmen often so far follow the traditions of their craft as to lose sight of such points of special advantage as might easily be grasped, if tradition were allowed to give way more freely to thought and experiment.

Here is the page of type, or "forme," which is to be moulded, and instead of being locked up in the chase surrounded with the ordinary wooden furniture, we have a type-high border about 3-8ths of an inch wide around it, but the face of this type-high border does not come quite close up to the type, there being a space of 1-8th of an inch between them. This type-high border is ordinarily obtained by surrounding the forme with strips of type-metal called "clumps," or "stereo-clumps," these clumps being type high, and about half an inch wide, but a bevel on the edge placed next to the type reduces the face-width to about 3-8ths, and gives the clear space of about 1-8th of an inch or so between the face of the clump and the type. The object of the clumps is to form a level bed for the strips of metal—commonly called "gauges"—which determine the thickness of the plate. The space between the type and the face of the clump leaves room for the saw-cut if the plate is to be trimmed close, or for the bevel if the plate is to be trimmed for mounting with catches on a metal block.

Now the forme should be planed level, not too tightly locked up, and its face must be slightly but completely oiled, this being done by rubbing it with a flat brush, not too heavily charged with oil, the brush being about as stiff as an ordinary hat brush. The traditions of the craft ordain that the oil should be the finest olive oil; but as a matter of fact, neither olive oil nor cotton-seed oil, which is now commonly sold as olive oil, is the most suitable, as these oils—and more especially the latter—are saponified very readily by any trace of alkali which may remain on the forme. A much more suitable oil is the very thin mineral lubricating oil which is sold retail at about 1s. 6d. a gallon. Here is a case in which an article sold at the lowest price is the best, and in connection with stereotyping—as indeed with most industries—there are many such cases; so much so that one must look with suspicion on the common but vague instruction to "use only the very best materials." The practical interpretation of this is to use just those samples for which the shopkeeper chooses to charge the highest prices; and when such an instruction is given as generally applying to all materials used in a craft, one may perhaps reasonably suppose that it is given because the instructor's knowledge of the materials is too uncertain for him to specify what qualities are desirable. Generally speaking, the forme is slightly warm when oiled; if it is cold and damp the oiling is almost certain to be unsatisfactory, and the mould may adhere to the type.

We now come to a very important matter, the flong and the materials used in its preparation. First, let us take the paste used to cement the various layers of paper together, and as to this matter one finds in the usual instructions merely a confusing crowd of recipes without the smallest indication as to choice between them, and some of these recipes order the use of materials the special service of which it is very difficult to conjecture.

As an adhesive, ordinary gum (arabic or acacia gum) is undesirable; it penetrates the substance of the paper, tends to make it unmanagably hard and brittle when dry, and, weight for weight, it gives less adhesion be-

tween sheet and sheet than is the case with starch or flour paste. Gum is especially bad in relation to the fine tissue which forms the face of the flong, as in penetrating this, it not only tends to adhesion with the type, but where the gum has penetrated, the face of the cast obtained will have a rougher texture than elsewhere. In addition, gum is expensive, and, what is perhaps worse, very variable in quality.

Starch paste is a very good adhesive, as its water principally penetrates the sheets, leaving the starch where most wanted, and that sponginess which is a characteristic of good and useful flong is retained.

Good as simple starch paste is, a paste made from a moderately glutinous flour, such as wheat flour, is better, as the gluten gives the starch greater consistency and adhesiveness without other disadvantages. Moreover wheat flour paste is easier to prepare and to manipulate than starch paste, and, if measured by adhesive power, is very much cheaper. Moreover, it penetrates the paper even less than starch paste. Altogether the advantage rests with wheat flour paste as the main adhesive.

Glue (the term includes gelatines and sizes) by itself is not a very suitable or desirable adhesive to use, it being subject to the same disadvantage as gum arabic as regards penetration of the paper, yet in a lesser degree; but when used in conjunction with sufficient flour paste, the penetrating quality is eliminated, and owing to the setting of the glue the flong acquires increased sponginess, and also the valuable quality of being more rapidly compressed by the face of the type when the metal is warm, as the glue melts and consolidates the compressed parts. In addition, by the use of glue along with flour paste, the flong becomes capable of holding rather more water without becoming flabby, and where the flong is not compressed, it dries more spongy than would otherwise be the case. There is advantage in using glue with the paste, whether the type is to be moulded cold or warm, but very especial advantage in the latter case. The sort of glue most suitable is the soft and degenerate glue sold retail in the oilshops at 4d. per lb., high-priced hard glues and fine gelatines being very much less suitable. Instead of using glue, it saves time to purchase size, but care should be taken to use the low-priced size sold as common size (14 lbs. 1s. in London oilshops), and not the harder and finer size known as "patent size."

We may then dismiss all adhesives but flour paste and glue; the former can be used by itself, but glue by itself is not very satisfactory. Together they give the best result, for reasons already stated.

It is desirable to mix some mineral matter with the paste, and for this use we find, among other additions, the following recommended:— Whiting, litharge, white lead, kaolin, other clays, Paris white, zinc white, barytes white.

The use of the mineral matter is two-fold. It makes the compressed parts of the mould more hard and stony than they would otherwise be, and less subject to blister or scale during drying or casting, and it makes the uncompressed parts of the flong more spongy and uniform in texture. At the same time it makes the whole mould more resistant of heat.

Of the above, the only very definitely objectionable substances are litharge and white lead, as owing to the moisture and heat the lead poison is specially liable to be absorbed into the system of the workmen; and of the rest, whiting seems to me the best, its softness of texture, fineness, and the ease with which it is compressed, enabling it well to fulfil the double function as stated above. At any rate, I am quite sure that not one of the above is superior to whiting; whiting, moreover, is cheap and easy to get.

We now come to the preparation of the paste. Into this iron pan I put—

Whiting	6 lbs.
Water	20 lbs. (2 gallons.)

If the whiting is allowed to remain in the water for an hour or two it will be found that the lumps have completely broken down, and the mixing will be easy, a point I can illustrate by mixing up a similar batch, which was set by to soak before the commencement of the lecture. If, on the other hand, I try to mix this whiting which has only just been put in the water, it works into clots and becomes unmanageable. The hands form the most convenient tools for mixing the whiting and water, as also for working in the next addition:—

Wheat flour..... $4\frac{1}{2}$ lbs.

This being thoroughly incorporated, the pan is set over the gas for the mixture to boil, it being constantly stirred with a wooden stirrer, having a T-shaped head which can be kept in motion close to the bottom of the pan, and so eliminate all chance of burning. As soon as the mixture boils the glue or size is added:—

Soft size ..... 14 lbs.
or
Common glue.... 3½ lbs.
Water ..... 10½ lbs (a gallon and nearly half a pint)

The glue to be soaked in the water till quite soft.

In order to give the paste such keeping qualities as shall ensure the mass keeping good for years, four ounces of phenol* (carbolic acid) are now stirred in, and all that remains to be done is to work the mixture through a sieve having about twenty meshes to the linear inch, or it may be strained through a piece of net.

Three sorts of paper are used in making the flong. First, a fine hard tissue paper for the face; secondly, blotting paper to form the porous body; thirdly, stout and tough brown paper for the back, to give strength and to support the blows of the beating brush. It is of very great importance that the tissue paper which forms the face of the flong should be strong and fine in fibre, uniform in texture, and free from holes, all qualities which add to the expense of a paper, and any expenditure which secures the above is well bestowed, any economy on this score being bad policy. A tissue which becomes pappy and soft when in contact with the paste, or which allows its exudation through holes, may cause adhesion between the forme and the mould, with the attendant delays and disadvantages. The tissue papers sold for pottery transfers are generally very suitable for stereotyping, and some makers supply a special kind. The sort I am using is sold at Lloyd's paper-office in Crown-court, at 11d. per lb., and it is made to a special size, 24 inches by 56 inches, so as to be suitable for newspaper work.

As regards the blotting paper, the cheaper sorts answer as well as the more expensive, and I do not think the lowest priced papers contain irregularities or lumps so pronounced as to be disadvantageous. That which I am using is demy paper, weighing 23 lbs. to the ream, and costing 10s. 6d. per ream.

The brown paper for the back of the flong should be made of tough, strong fibre, free from knots and lumps; moreover it should be soft, and not heavily rolled. Such a paper is expensive, costing about 4d. per pound; but, as in the case of the tissue, it is poor economy to use a backing paper of unsuitable character.

* The carbolic acid should be the tolerably pure white crystalline kind, usually sold in 1 lb. bottles, not the very crude, oily, and brown product used for pouring into drains.

I will now prepare some flong, the materials being:—

	Approximate weight in grains.
Brown paper (1 square foot)	200
Blotting paper, 3 thicknesses (3 square feet)	355
Tissue paper (1 square foot)	25
	580

The brown paper is laid flat and pasted uniformly by means of a rather soft, flat brush, the paste being, by preference, slightly warm, on account of the glue it contains, although with the above-mentioned proportions it is possible (though undesirable) to work it cold. A sheet of blotting is now laid on, and the pasting is repeated between each layer of paper, but in the case of the last pasting, which holds down the tissue paper, only a small quantity of paste should be applied, and that as uniformly as practicable. A convenient way of laying down the tissue paper is to roll it on a wooden cylinder, and then to roll it off this on to the pasted surface; and all through the operation great care should be taken that no paste comes in contact with the outside face of the tissue; generally speaking, the wooden roller requires wiping after each use. Close contact of the several constituent sheets of the flong is best insured by laying a clean paper over it after each addition, and rubbing down with the hand, or with a cloth folded so as to form a pad. Hard rolling is best avoided, as it tends to lessen that sponginess which is so desirable a quality. If the paste has been applied in about the right quantity, the square foot of flong, the paper of which weighed about 580 grains, will, when wet and fresh, weigh about 1,400 grains, about 820 grains of this being paste; in this state it is too wet and too soft for convenient use, but if exposed to the air until something like 300 grains of water have evaporated—that is to say, until the square foot weighs about 1,100 grains—its consistency will be right for working. These weights are given principally in order that persons working from directions may be able to prepare a sample which shall have a convenient consistency, after which the remembrance of this sample should be a sufficient guide.

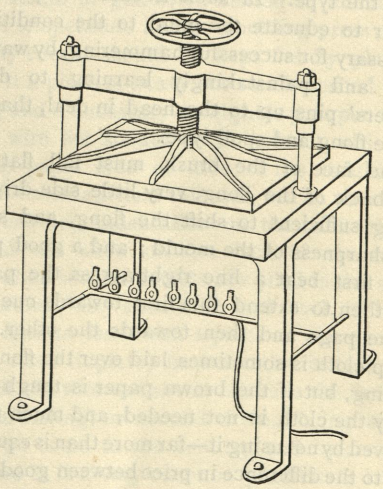
It is desirable to prepare the flong in the first instance with excess of moisture, and to allow this to evaporate spontaneously, as during this process of evaporation the paper swells and takes a plasticity and sponginess which is difficult to obtain in any other way.

Moreover, the manipulation of making the flong is easier and more satisfactory when a soft paste, containing a full proportion of water, is used. If, however, one has occasion to prepare a piece of flong for immediate use, the best way is to employ as little paste as practicable. Quite apart from the question of the amount of moisture present, it is undesirable to make use of freshly prepared flong, as it is never so homogeneous as that which has been kept for some days. It may be kept in a varnished tin tray of the right size, a stout plate of zinc being laid on the top. Generally speaking, it is best to lay the sheets of flong face to face, as the backs are likely to have been soiled with paste, and paste should be kept from the face. Flong prepared with the above-mentioned paste will keep any length of time without decomposition or mildewing, but it may become partially or completely dry. This may be remedied by one or more dippings in water, with a full allowance of time for its absorption. When flong has completely dried it is rather a trouble to get it once more in good working condition, the best way being to dip it in cold water, pile it in the storing tray, and keep this latter in a warm place, repeating the operations if necessary. Dry flong is an article of commerce, but it is more trouble to get it into good working condition than it is to start with the plain sheets of paper. It is often recommended to use two thicknesses of tissue paper on the face of the flong, and to interpose tissue between the several sheets of blotting paper, but these courses are open to objection, and, as far as my experiments go, have no balancing advantage. Two thicknesses of tissue on the face, with paste between, offer no greater security against paste reaching the type than does one thickness of tissue, and, moreover, for ease and rapidity of application, it is desirable to make the paste as fluid as practicable, and also to so work as not to involve the extra care and labour consumed in applying very thin layers of paste, and it is obvious that the larger the proportion of thin paper entering into the composition of the flong, so much thinner must be the layers of paste in order to obtain flong containing the same proportions of paste and paper. It takes much longer to spread a very thin layer than a moderately thick layer of paste.

Ease and quickness in working is generally on the side of moulding small forms rather than large, so that, when work is sent in assemblages of many pages, it is often desirable to re-impose, so as to bring down the dimensions to demy folio or thereabout; but when large pages of close matter, such as newspaper pages, are concerned, the stereotyper has no option but to mould the forms as received. When several pages are imposed together for moulding, it is sufficient to allow a pica (1-6th of an inch) between them, unless the edges are to be bevelled; in which case quite twice as much space will be required to allow for the saw cut and two bevels. The type-high clumps, as before stated, surround the whole.

Sometimes the stereotyper will have to clean the forme himself, from the carelessness of the printer who sends it to him, and in this case it should be scrubbed over with a solution of the cheapest quality of caustic soda in water (one part of soda to about eight of water), well rinsed and dried. Here, then, is the forme, clean, dry, oiled, warm, and resting on a planed slab of iron, or "beating surface," heated from underneath, the heating

FIG. 2.



THE DRYING PRESS.

being in this case by gas,* although in a factory it is often more convenient to use steam. The hand is now lightly passed over the face to detect any letter which may stand high, and the planer is brought into use it necessary.† All is now ready for the moulding. I take a piece of the flong, dust its surface over with powdered French chalk, taking care to wipe off all excess, then lay it

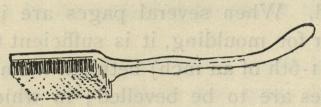
* The beating surface may be, and often is, an extension of the bed of the drying press (Fig. 2).

† The planer of the printer is a slab of hard wood, which is placed on the forme, and then struck with a mallet,

face downwards on the forme, and now comes the operation of beating.

The brush used for beating may vary in

Fig. 3.



The Beating Brush.

shape or weight, according to the habit of the workman, but the bristles must be good and closely packed, and the operation of beating is so similar to that of driving in a nail, that any person who is able to strike his nail every time in such a way that it shall be sent forwards and without any tendency sideways, will probably make a satisfactory mould the first time; while one in whose hand the hammer sways round uncertainly and uncontrolledly, hitting the nail at all sorts of angles, and perhaps even bending it, will not be very successful in making a paper mould from the type. In such a case it is perhaps better to educate the mind to the conditions necessary for successful hammering, by watchfully and painstakingly learning to drive drapers' pins up to the head in deal, than to waste flong and spoil type.

The face of the brush must fall flat on the back of the flong, very little side-driving being sufficient to shift the flong, and spoil the sharpness of the mould; and a good plan is to first beat a line right across the page, and then to extend this first towards one end of the page and then towards the other. A damp cloth is sometimes laid over the flong in beating, but if the brown paper is tough and nervy the cloth is not needed, and much time is saved by not using it—far more than is equivalent to the difference in price between good and bad paper. Moreover, when the cloth is used it becomes difficult to give such local treatment as is necessary on parts where words or rules stand almost by themselves, or where there may be a mass of small type closely set, to say nothing of the special treatment required where engravings are included in the forme. As a rough guide to the extent to which the beating is to be continued, it may be stated that with flong of the right degree of softness the divisions between the words set in long primer or brevier should show distinctly on the back of the flong. If the flong is very soft, the beating must not be continued until these divisions are so distinct as with normal flong, and if the flong is very hard one will only obtain sufficient relief by making the divisions show very clearly.

The progress of the beating may always be seen by steadying the mould with one hand and turning back one corner, and the flong should always be so soft that this can be done without straining or stretching the part turned over. All this work of moulding by beating takes, as you may see, very much less time to do than to describe. Where there are extensive whites in the forme the mould will be arched downwards, and some support is needed in such places, or the arched parts would crush down by the weight of metal in the casting-box, and much metal would have to be cut away from the plate. The usual way is to paste the back of the flong, and to lay in the deep parts a few pieces of paste-board or of old mould, after which a second sheet of brown paper is pasted and laid over all. A very gentle beating is now given to the mould, care being taken not to beat this last paper down into the hollows, as the main use of this sheet is to string or tie the domes and hollows formed in the main part of the flong.

Another way—more employed in newspaper offices—is to fill in the hollows with whiting, or dry plaster of Paris may be used; the pasted sheet of brown paper being laid over as before.

The impression is now sharpened up by planing. The printer's planer—which is a slab of hard wood—is placed on the mould and struck several times with a mallet. This should be repeated several times, moving the planer between-times, and care must be taken not to shift or strain the mould sideways. Two or three thicknesses of blanket, or still better, enough blotting paper to make up about half an inch in thickness, being placed over the mould, the forme and mould are pinched up in the drying press (Fig. 2).

A few words more about the beating brush. If the face is not level, or should become unlevel by use, it may be burned flat by contact with a plate of iron heated to a dull redness, and by the same means the edge and corners farthest from the handle may be very slightly sloped off, this making it more easy to give local treatment to any special part of the mould. Workmen who have skill and confidence in the use of the brush may strike tolerably hard, and they often find it a convenience to load the brush by fastening a plate of lead to the back. Some of the Continental workmen, instead of using a brush, prefer to use a wooden blank provided

with a handle and covered with several thicknesses of soft cloth or "moleskin." Then, again, a rolling machine, or a vertical press, is occasionally used in making the mould, but the press and rolling machine are of little use except in the case of tolerably solid and uniform formes, such as the pages of a newspaper. The rolling machine for moulding consists merely of a moving bed with an adjustable cylinder over it, bed and cylinder being geared together. The machine, however, is seldom used without the brush being used as an adjunct. Sometimes the press or machine is used to set the flong firmly in position on the type, the brush being used for finishing, and sometimes the brush is used first, and the machine is employed to sharpen up the impression; to do what the planer does in the process of making a mould by hand.

A sufficient drying of the mould may be effected in as short a time as three or four minutes, in which case the heat is urged almost to the softening point of the type, or the heat may be more moderate, so that the drying takes as much as half an hour. It may, however, be taken that in the case of ordinary commercial stereotyping some water is invariably left in the mould; many hours baking at a temperature of 200° Centigrade being necessary for the removal of the last traces of moisture. So that, when the best possible results are required, it is desirable (as I shall point out farther on) to considerably extend the time allowed for drying.

In ordinary cases—the work not being subject to the extreme need of haste which exists in the case of newspaper stereotyping—the forme will remain in the drying press for ten or fifteen minutes, during which time the blanket (or covering of blotting paper, as the case may be) may have been changed two or three times, or if this is not done, the press should be undone, and the covering turned over to allow the more ready escape of moisture. All this time the bed of the press may be conveniently heated to a temperature from 100° to 130° Centigrade; the former being about the degree of heat obtained if the bed forms the top of a a steam chest fed with waste or "exhaust" steam, but if "live" steam of about 30 lbs. pressure is used, the temperature will be something like 130°.

Now let us return to our forme and mould. The mould leaves the forme at once. When any adhesion occurs, something is wrong with the work, and this must be obviated in future,* but a slight tendency to adhere can generally be combatted by repeatedly lifting the edges of the mould as far as is possible without bending or straining the mould, and then letting it spring back; at the same time slightly loosening the quoins and beating the back of the mould with the brush will assist. In the case of persistent sticking, the only alternative is to heat the forme once more and repeatedly moisten the back of the mould with water. In this case the mould will be spoiled.

The mould, as it comes off the forme, is dry to the touch, but ordinarily not dry enough to give a good cast, and before drying it further it is convenient to trim the edges to the outsides of the gutters left by the clumps, and paste† on to one end a flap of brown paper long enough to project two inches or so out of the casting-box, and, at the same time, to allow a head of metal of not less than six inches.

The mould may now be laid on a hot surface to further dry, or, better still, it may be baked in a steam or gas-oven, heated to about the same temperature as the moulding press; but in any case it should be kept flat by placing over it a piece of heavy but small-meshed wire net,‡ and if necessary a weight is put upon this. The wire net should be in contact with the tissue paper side or face of the mould, as slight indentation on this side will do no harm, whereas any indentation on the back of the mould will show on the face of the cast; and when several moulds are piled in the oven for baking, they should be laid back to back and face to face, with a piece of sheet metal (say stout tinplate) between the backs, and one of the wire-net sheets between the faces.

The baking, or second drying, being at an end, we come to the casting, and before this is done it is a very common practice to brush some finely powdered French chalk into the

* Tissue paper not impervious; excess of paste under tissue paper, thus breaking up tissue; tissue broken in beating, from too hard blows or extreme softness of flong; mould too deep, so as to fit over the shanks of the types, or even penetrating between them; paste on face of the flong, from careless making or piling; imperfect oiling of forme, or unsuitable oil; alkali or other foreign matter on type.

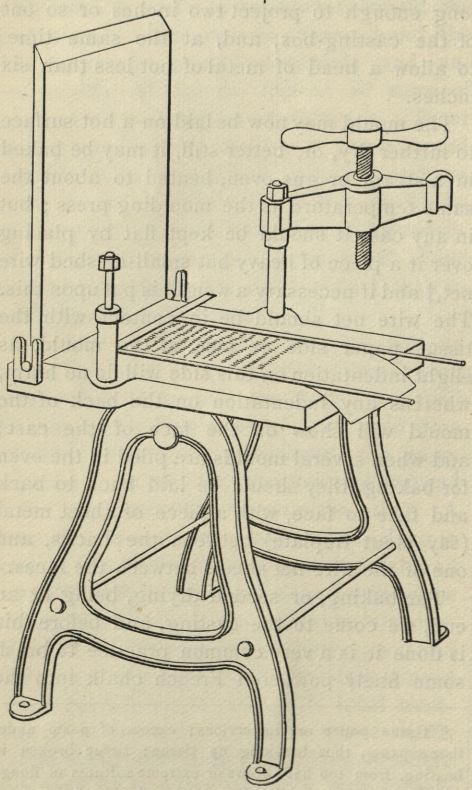
† For this purpose a more adhesive paste is required than that used for making the flong. Stiff rye flour paste is best.

‡ A suitable wire net is made with iron wire of No. 16 I.W.G. (·064 inch diameter), and six meshes to the linear inch, and can be had from firms that furnish millers' plant. The ordinary wire gauze or net sold at the hardware shops, having six meshes to the inch, is made of much thinner wire, and is not much use for our present purpose, as it has not sufficient rigidity to keep its shape as a slab or plate.

mould, and then to dust out the excess by turning the mould face downwards, and gently beating the back with a flat slice of cane. This is quite unnecessary if the mould is very dry; but by the use of French chalk the effect of any trace of moisture remaining in the mould is minimised, and, moreover, the cast separates from the mould more easily—a matter of some importance when it is wished to make several casts in the same mould.

All is now ready for laying the mould in the casting-box, the casting-box having been warmed by a gas jet underneath, or I might have warmed it by casting a few blanks in it. The mould is laid face upwards on the horizontal slab of the casting-box (Fig. 4), the

FIG. 4.

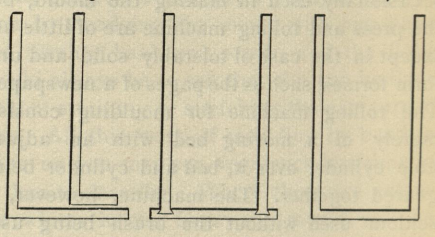


THE CASTING-BOX.

brown paper flap hanging a little over the lip of the box. The pica-high gauges are laid along the gutters formed by the clumps, the top leaf of the box is closed down and clamped by the screw, and the casting-box is swung on its axis, so as to bring the lips to the top.

When stock sizes have to be stereotyped it is convenient to use set gauges, like Figs. 6 or 7, but in other cases it is usual to employ adjustable gauges, such as Fig. 5.

FIG. 5. FIG. 6. FIG. 7.



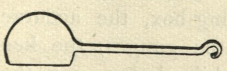
STEREOTYPE GAUGES.

When the mould is charged with type-metal, it is necessary, in order to obtain a good cast, that the whole of the metal inside should remain fluid until the mould is completely filled with metal, as if any part solidifies before the mould is full, the cast is sure to show curved streaks where the cast has solidified, and the fresh metal has not run up so closely as to make a sound cast. This is most noticeable at the back of the cast, where the casting-box exercises the most sudden cooling action on the metal, and the object of heating the casting-box is to diminish the tendency to this sort of thing. Heating the casting-box is generally insufficient in itself, when the cast is large, unless the heat is raised to nearly the melting point of the metal—an obviously inconvenient course. It is very much more convenient and satisfactory to warm the box only slightly (say to about 100° Centigrade), and to cover the face with a non-conducting coating, a coating which may be extremely thin, in fact, it is sufficient to sponge the iron plate over with a very thin wash of jewellers' rouge (finely divided ferric oxide, or, practically, much the same thing as finely divided iron rust) and water, a film of the oxide so thin as to be scarcely noticeable serving to retard the solidification of the metal during the short time required to fill the mould. Although a thin wash of jewellers' rouge is the best coating material to employ when very delicate castings of type metal are to be made in metal moulds (as, for example, in casting the thinnest "leads"), a thicker and coarser mixture, made by stirring a ¼ lb. of red ochre into half a pint of water, is often used; this being applied with a brush. London stereotypers, however, more usually lay a sheet of thin cardboard over the back plate, or a sheet of thin paper will serve, the thin paper being quite as effectual as the card in preventing the chilling of the metal, but stereotypers generally prefer the card, as

lasting longer and being easier to handle. The card, however, is liable to blister, and so cause inequalities in the thickness of the plates. In this connection I may mention that, in the absence of a metal casting-box, excellent work may be done by using two slabs of dry wood, held together by screw clamps.

All is now ready for the casting of the stereotype. In this pot is some metal ready melted, and soon I shall have something to say as to the composition of the metal. To ascertain whether the temperature of the metal is about right, a strip of card or of old mould is immersed in it for a few seconds. If the card becomes of a medium brown the heat is right (about 320° to 330° Centigrade), while if it chars and blackens the temperature is too high. Should it, on the other hand, merely become yellowish or light brown, more heat must be applied; when the metal is too hot it can be rapidly brought down by stirring in some cold metal. It is important that, when poured, the surface of the metal should be clean and free from scum or oxide, as this might lodge in the cavities of the mould and render the cast unsound; and the most convenient way of cleaning the surface is to throw into the pot some powdered resin, which melts and so far agglomerates the oxide that it can readily be removed by skimming with a perforated iron spoon. Sufficient metal is now taken out of the pot by an iron ladle—one with a flat pouring-side (Fig. 8) is often used—and the metal is poured steadily, but not so quickly as to cause splashing, into the mould. Under ordinary circcumstanes it

FIG. 8.



FLAT-SIDED LADLE.

makes but little difference whether the stream is poured against the back plate of the casting-box or against the face of the mould, although the former is the most usual course, and some persons make a point of drawing the ladle along the lips of the mould during the operation of casting.

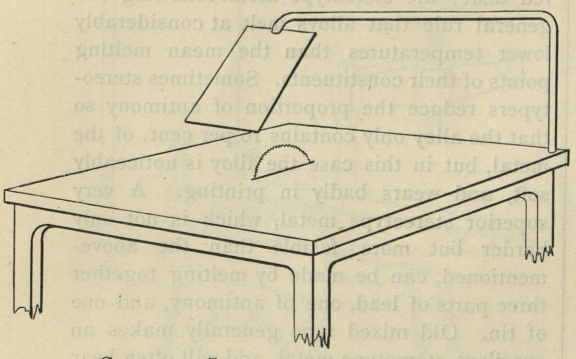
The metal used for stereotyping is much the same as ordinary type-metal, only, as a rule, the stereotyper is content with an alloy tending too much towards softness, while of late years type founders have been moving in the direction of harder and harder metal. An alloy well suited for ordinary work contains 20 per cent. of antimony, the remainder being lead; or lead 4 parts, antimony 1 part. For preparing this alloy, a very safe lead to use is the soft lead which has formed the linings of tea-chests, or if commercial pig lead is used, a soft sample should be selected, and this may be sufficiently judged of by scratching the surface with the finger nail. Hard pigs often contain traces of zinc; this metal, which is especially bad in stereotyping alloys, being used in some of the desilverising processes, and the last traces are not always removed. When, however, the hardness of the pig lead is known to be due to antimony, copper, or tin, it may be used quite safely; in fact, the hard lead then becomes more desirable than soft lead. The lead and antimony being put together into the iron melting pot, sufficient heat is applied to melt the former, when the antimony gradually dissolves in the melted lead, forming an alloy which fuses at about 300° Centigrade. Lead melts at something like 330° Centigrade, while antimony fuses at 450° Centigrade, or a low red heat; the stereotype metal following the general rule that alloys melt at considerably lower temperatures than the mean melting points of their constituents. Sometimes stereotypers reduce the proportion of antimony so that the alloy only contains 10 per cent. of the metal, but in this case the alloy is noticeably soft, and wears badly in printing. A very superior stereotype metal, which is not only harder but more fusible than the above-mentioned, can be made by melting together three parts of lead, one of antimony, and one of tin. Old mixed type generally makes an excellent stereotype metal, and will often bear the addition of nearly half its weight of lead. Type metals, like so many alloys, are harder when the cooling has been very rapid than when it has been comparatively slow, and casts obtained, in a given alloy, by the paper process, are consequently softer than those by the striking process of Carez and Didot (Lecture I., p. 3).

The most positively objectionable impurity likely to find its way into the stereotyping metal is zinc, this metal making the alloy flow badly, and the face of the cast rough and patchy, doubtless by its tendency to separate from the other metals. It is, therefore, important to keep watch against its introduction into the stereotype foundry, and in melting up old type or scraps, any portions which remain unmelted, and float on the surface after the bulk is fused, should be skimmed off, as these are likely to contain the

lighter and less fusible zinc. The larger the proportion of lead in the stereotype metal so much greater is the evil effect of the zinc. Zinc in lead or in type metal may be removed by calcining at a low red heat, the zinc oxidising with the first portions of the lead; but the same treatment also removes the antimony, or at any rate a considerable proportion of it. The tendency of antimony to oxidise is so much greater than that of lead, that stereotype metal used many times becomes softer from the loss of antimony. A little arsenic—say 1 or 2 per cent.—increases the fluidity and hardness of a stereotyping metal.

We now take the cast out of the box, and the usual thing is to trim it, or cut it up into pages with a circular saw, and as the cuttings are carried round by the saw, and thrown upwards and forwards by the ascending side, it is usual to fix a screen (as shown in Fig. 9), to prevent them going into the eyes

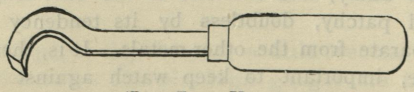
Fig. 9.



Circular Saw with Celluloid Screen.

of the operator. The screen is ordinarily made of sheet metal, but you see in the case of the saw bench sent here by Messrs. Harrild and Sons, a neatly fitted and curved glass plate is used. Generally speaking, however, I have preferred to use a leaf of the transparent flexible celluloid, which can now be readily obtained as thin as a card, and as transparent as glass.

Fig. 10.

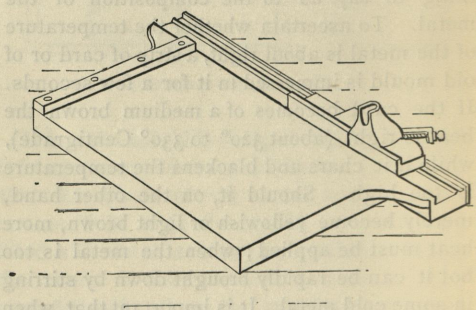


The Zinc Hook.

Instead of a circular saw, the tool known as a zinc hook (Fig. 10) may be used for dividing the plate. A metal straight-edge is used as a guide, and the cutting edge of the zinc hook is drawn along it a sufficient number of times to plough a groove half through the plate, when it becomes easy to break it.

For trimming the edges a hand plane is ordinarily used in conjunction with a shooting board, the ordinary wooden shooting board and jack-plane of the joiner answering the purpose very well. The cut (Fig. 11) represents an

Fig. 11.



Iron Shooting Board and Plane.

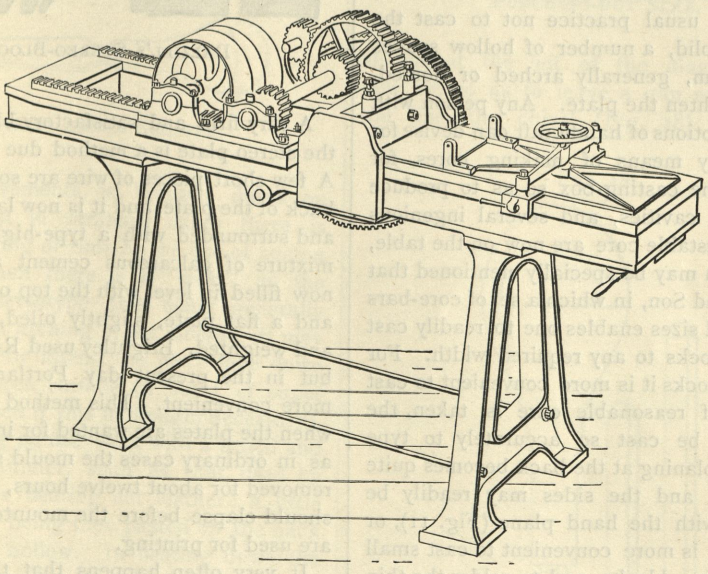
iron shooting board and iron plane specially made for stereotypers' use, a second plane being provided for bevelling. When the trimming planes are driven by power, the arrangement is generally substantially similar, the plane moving to and fro on a guide, while the plate to be trimmed is fed up against it, although sometimes a revolving cutter is used instead of a plane.

Thin stereotypes, cast pica-high for mounting on blocks, ought not to require planing at the back, provided that reasonable attention is devoted to matters which influence their thickness and truth, such as the flatness of the slabs of the casting-box, the accuracy and right placing of the gauges, the keeping of the mould flat while drying, and the proper condition of the cardboard covering the back slab of the casting-box. It is easy to cast plates so true as to require no planing, indeed so true that the arrangement ordinarily used for planing, or rather scraping, the backs of thin stereotypes, would make them worse, not better. The arrangement is a kind of drawbench in which the plate is slowly forced under a stout knife placed almost vertically, and one form of it is represented by Fig. 12 (p. 15).

On referring to the diagram it will be seen that the travelling part is one with the two racks, while the double gearing and the arrangement for reversing by shifting the strap from the middle pulley—which is idle—to the right or left, according as one wants

backward or forward motion, will be obvious to anyone who has given attention to machinery. The slow heavy cut, with a cutter at right angles to the plate, is essentially wrong, and tends to drag the plate out of shape, and, unless care is taken, will sometimes lift it from the bed of the machine. A machine tool for cutting stereotype metal will not work efficiently at a much less speed than twelve feet per second between it and the metal. In ordinary cases the cut is clean and easy with such a speed and an angle of 60° on the approaching side, and 15° is a good angle for the cutting edge, leaving an angle of relief of 15°. When a cutting tool rapidly removes small shavings of stereotype metal—as in the case of a circular saw or rotary cutter—there is a tendency for the clean particles of metal to weld together, and also for some of them to weld upon the clean surface of the work, thus making it rough, but a minute film of thin mineral lubricating oil prevents the tendency to welding, and it is generally sufficient to allow a brush charged with the oil to very lightly play against the cutter or the work, according to circumstances. The free use of oil on stereotypes is objectionable for obvious reasons. For heavy work water

FIG 12.

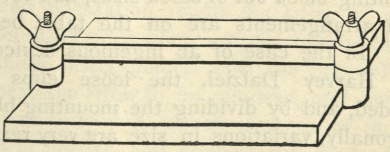


DRAW BENCH FOR SCRAPING THE BACK OF THE PLATE.

containing a little soap is more efficient, but it must be used freely. The above remarks as to the relation of stereotype metal to cutting tools apply more especially to the ordinary and rather soft alloy. It is a matter of surprise to me that a planing machine with a revolving cutter, like that used for thicknessing floor boards, is not always used for the backs of stereotypes when planing is required.

In most cases—at any rate for jobbing work—the stereotype plates are brought up to type height by being nailed or screwed down on mahogany boards, these being, roughly speaking, three-quarters of an inch high; and, from the printer's point of view, it is very desirable that the thickness of the whole should exactly equal the height of the type, a matter which may very well be gauged by a sort of bridge (Fig. 13), under which the mounted stereotype can be just passed if it is the right height. Wood blocks expand when exposed to damp, and contract when they dry, and consequently

FIG. 13.



GAUGE FOR HEIGHT.

they vary from time to time; so printers, when using wood-mounted stereotypes, would save time by passing them one at a time, and face downwards, under such a bridge set to type height. The low places can then be readily

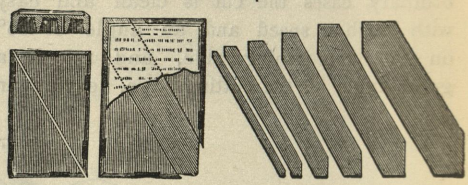
brought up with paper patches in far less time than when made up in the chase. As a matter of fact, stereotypers very seldom send out the blocks too high, as the printer finds it much easier to pack up than to plane off.

Printing from stereotypes becomes much more easy and certain if, instead of being mounted upon a material which, like wood, varies in thickness with difference in the degree of dryness, the stereotypes are either cast type high in the first instance, or are mounted upon some firm foundation not subject to considerable variations of thickness.

Casting the plates type high is a common practice for ephemeral work, as in that case the plates can be melted as soon as done with; but it is the usual practice not to cast the plate quite solid, a number of hollow spaces at the bottom, generally arched or domed, serving to lighten the plate. Any person with elementary notions of handicraft can devise for himself ready means of making cores for placing in the casting-box so as to produce the required cavities, and several ingenious forms of adjustable core are now on the table, among which may be specially mentioned that of Harrild and Son, in which a set of core-bars of graduated sizes enables one to readily cast type-high blocks to any required width. For very small blocks it is more convenient to cast solid, and if reasonable care is taken, the blocks may be cast so accurately to type height, that planing at the back becomes quite unnecessary, and the sides may readily be squared up with the hand plane (Fig. 11), or sometimes it is more convenient to cast small metal mounting blocks, and to solder the thin stereotypes upon these.

Metal mounting-blocks, upon which bevel-edged stereotype plates are held by catches placed round the edges, are on the market in various forms, much cleverness being sometimes noticeable in the devices for enabling the printer to build up any required size of mounting-block out of stock sizes, and several such arrangements are on the table before you. In the case of an ingenious device by Mr. Harvey Dalziel, the loose clips are avoided, and by dividing the mounting block diagonally, variations in size are very readily provided for by the insertion of suitable distance pieces. Fig. 14 illustrates the arrangement. The small diagram at the west side is a sectional view showing the clips, which are one with the blocks, and it also shows the coring of the blocks, while the diagram under it shows a pair of twin blocks in plan. Next we have the same adapted for a larger plate by the insertion of one of the various distance pieces, a series of which is shown on the outer side of the group. Fine adjustments can be made by inserting an ordinary lead, and it is obvious that these adjustments can be made to take effect either across or along the page, or may be apportioned between the two.

FIG. 14.



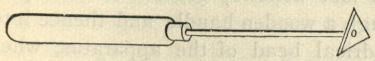
DALZIEL'S STEREO-BLOCKS.

A very firm and satisfactory blocking up of the stereo.plate is a method due to Brightley. A few short pieces of wire are soldered to the back of the plate, and it is now laid on its face and surrounded with a type-high border. A mixture of calcareous cement and water is now filled in level with the top of the border, and a flat plate, slightly oiled, is laid over and weighted. Brightley used Roman cement, but in the present day Portland cement is more convenient. This method is unsuitable when the plates are wanted for immediate use, as in ordinary cases the mould should not be removed for about twelve hours, and two days should elapse before the mounted stereotypes are used for printing.

It very often happens that the stereotype requires some work done upon its face, such as cutting away the parts corresponding to large white surfaces, raising low parts, or "sinks," or soldering in letters or electrotypes. For chipping away extended whites, a very convenient tool is the ordinary carpenter's gouge, driven by a rather light mallet, an assortment of four or five gouges, the narrowest about three sixteenths of an inch across, being ample. When chipping away the metal with gouge and mallet, it is desirable to place the stereotype on a planed iron surface, provided with a transverse bar against which it can rest, the iron shooting board (Fig. 11) being convenient for this purpose. For working in narrow places, and close up to the type face, a "firmer" chisel of suitable width may be used, or a scraper shaped like Fig. 15 (p. 17), and one angle of the scraper may advantageously be ground on the edge of the

grindstone, so as to shape it into a chisel-like tongue about a sixteenth of an inch wide, or a

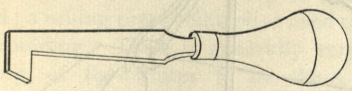
FIG 15.



TRIANGULAR SCRAPER.

special tool, like Fig. 16, may be used for scraping between the lines. Sometimes a routing-out machine is used, in which a conical dome-shaped revolving cutter, provided with

FIG. 16.

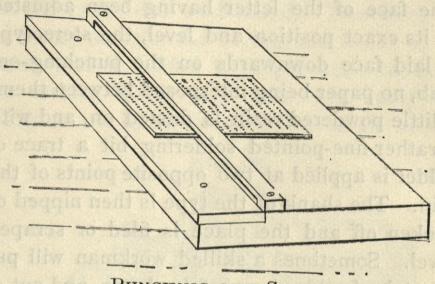


PARALLEL-ENDED SCRAPER.

universal movements, is brought down on the plate, but in ordinary cases there is little or no saving of time by the use of such a machine. When there is a "sink" on the face of the stereotype—this being generally the result of an arching of the mould*—it may be brought up by laying the plate face down on a planed iron surface (a sheet of paper being interposed if this is thought necessary), and hammering on the back with a broad and round-faced hammer, such as that used by shoemakers for beating out leather; a little paper packing being then pasted on the back to support the hollow. In beating down the "sink," care must be taken to strike in the middle of the place, rather than at the edges, and to strike the fewest blows that will do the work, otherwise the plate may be distorted so much as to render it useless. In the case of the thick curved stereotypes used for newspaper work on rotary machines, the machine minder will often bring up a low line† by driving a chisel obliquely into the metal above it and below it.

Cutting out a false letter and soldering in a type requires some care and watchfulness, but it is very easily done. The stereotype is clamped face upwards on the punching-out slab (Fig. 17), and with the line containing the false letter immediately in front of the bridge. The adjustable part of the bed,

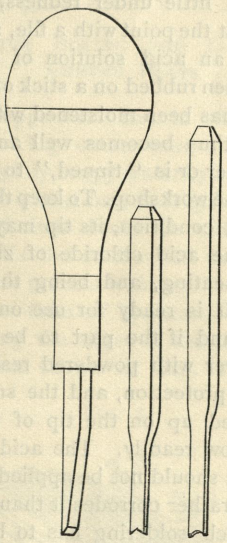
FIG. 17.



PUNCHING-OUT SLAB.

shown at the left of the diagram, being now set so as to leave a gap exactly under the line, the chisel (Fig. 18) is used to

FIG. 18.



TOOLS FOR REMOVING FALSE LETTERS.

make an indentation round the letter, at any rate on those sides where access can be had, the chisel being placed with the unbevelled side next the letter to be removed, and being held vertically. A punch like one of those shown in Fig. 18, and of the right size for the letter to be removed, is now held firmly atop of the letter, and is driven through the plate by a hammer. Any metal driven beyond the plane of the back may now be cut off with a sharp chisel, and if any indentation of the face round about the hole is visible it can be dealt with as recommended in

* May arise from a scrap of metal or other foreign body under the flong, penetration of liquid metal through a hole in the flong, or the joint of the paper flap, from distortions of the mould during drying, or by careless clamping up in the casting-box.

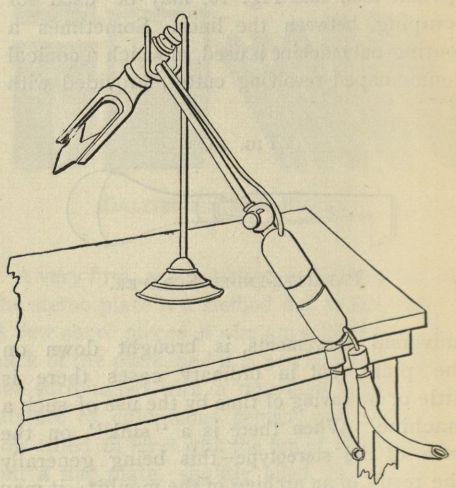
† The standing lines in newspapers and periodicals are often low to paper.

the case of a "sink" (p. 17). The hole is now trimmed, by means of a rectangular file,* to the bare size of the type to be inserted, and the type, after having been scraped clean on the sides, is inserted from the back. The face of the letter having been adjusted to its exact position and level, the stereotype is laid face downwards on the punching-out slab, no paper being interposed between them, a little powdered resin is dusted on, and with a rather fine-pointed soldering bit a trace of solder is applied at two opposite points of the join. The shank of the type is then nipped or broken off and the place is filed or scraped level. Sometimes a skilled workman will put a patch of solder over a false letter, and out of this engrave the required character, but such a method of working is more usually adopted when a dot or the tail of a letter is broken off and must be replaced.

The soldering is very easy if a few points are attended to. The copper bit being heated to a heat a little under redness, is rapidly cleaned about the point with a file, and quickly dipped into an acid solution of chloride of zinc,† and then rubbed on a stick of soft solder which itself has been moistened with the same solution, it thus becomes well amalgamated with the solder or is "tinned," to use the expression of the workshop. To keep the soldering bit in a good condition, its tip may be rapidly dipped in the acid chloride of zinc solution after each heating, and being then charged with solder it is ready for use on the stereotype plate, and if the part to be soldered is sprinkled over with powdered resin, this will be sufficient protection, and the small drop of solder carried up on the tip of the bit will unite and flow readily. The acid chloride of zinc solution should not be applied to the type metal, as it rather corrodes it than protects it.

When much soldering has to be done, as for example, if electrotypes of wood-cuts are to be soldered into stereotype plates, a soldering bit, heated by a small gas blowpipe, is a great convenience and saving of time, and the device represented in Fig. 19 is a specially convenient one for the stereotyper, this sketch, like some others I have put before you, being taken from Monet's very useful work, *Procédés de Reproductions Graphiques**, and the instrument itself can easily be constructed by any all-round mechanic. The tubes leading gas and air respectively (the air being conveniently supplied by a foot bellows) are shown first passing through a wooden handle and thence into the cylindrical head of the apparatus, where is fitted a small Herapath's blowpipe, the flame

FIG. 19.



SOLDERING BIT HEATED BY GAS BLOWPIPE.

of which plays upon the small copper bit held, as shown, by two lugs extending from the cylindrical head. A cock is placed on the gas-pipe just over the handle, and where it can be operated by the thumb of the right-hand, while the crutch shown on the figure forms a convenient support for the blowpipe when not in use.

Although very little care and attention on the part of the workman will enable him to use ordinary soft solder of the tinman without fear of melting the adjacent parts of the plate, there are cases where it may be desirable to use a more fusible solder, in which case Wood's cadmium solder may be employed. It melts at a temperature considerably under that of ordinary solder, works nearly as easily, and is quite as strong. It is prepared by melting together cadmium 2 parts, tin 4 parts, lead 2 parts.

An alloy of bismuth 2 parts, tin 1 part, and lead 1 part, forms a solder easy to use, moderately strong, and melting below the

* Files of rectangular section down to a square file about 1-50th of an inch across can be obtained at the watchmakers' material shops of Clerkenwell or Soho.

† Commercial hydrochloric acid saturated with zinc, and when poured off from the excess of metal, is mixed with one-fourth of its bulk of hydrochloric acid.

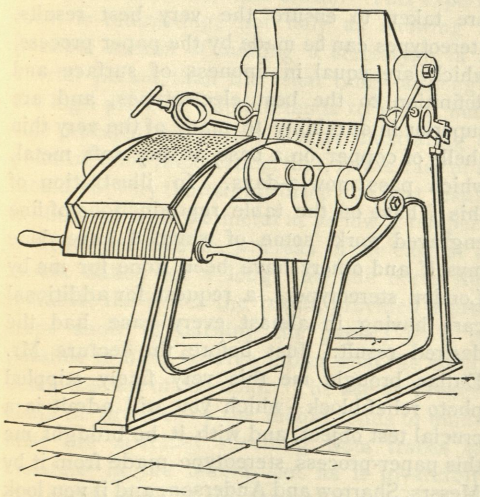
* Procédés de Reproductions Graphiques, appliquées a l'imprimerie, par A. L. Monet. Super royal octavo, 444 pages, 103 cuts in text, and 13 plates. Price 10 francs. Paris, 1868: Administration du "Bulletin de l'Imprimerie," 7, Rue Suger.

boiling point of water.* When figures have to be altered several times, this solder is convenient to use, as those first soldered in can be readily removed by immersing the plate in boiling water or heating it till, when touched with a wet finger, one can just feel steam formed, then giving the figure a slight tap to drive it out.

In stereotyping for newspaper work everything is carefully studied to attain speed, especially in the case of the evening papers, and it becomes possible to mould a page and cast a plate in about ten minutes. In such cases the plates are cast curved, so as to fit the cylinder of the machine used.

Two workmen beat the flong to make the mould; a rolling press being often used to finish the moulding. There is generally very little packing of the whites to be done, so it suffices to sprinkle a little whiting upon the back of the mould, and scrape it into the hollows with a straight edge, after which the final thickness of brown paper is pasted on, and the forme is run under a hot press to dry, the heat being as great as can be ventured upon without damage to the type. In two or three minutes the mould is removed, finally dried on a hot surface for another similar period, is dusted with French chalk, and is then placed in a curved casting-box (Fig. 20),

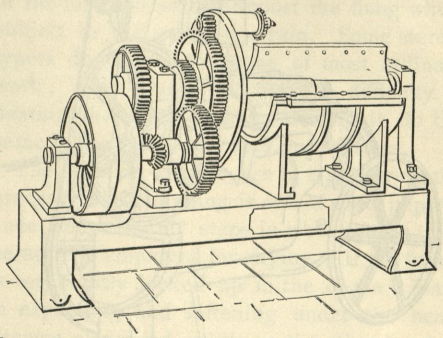
FIG. 20.



CASTING-BOX FOR CURVED PLATES.

the metal being poured in at the side of the page, while in the older pattern of curved casting-box it was poured in at the top. The metal is poured from a large three-handled ladle like that used in iron foundries. The trimming of the cast is generally done while it is warm, and by slow-moving tools, as chips rapidly removed from the hot metal are more likely to weld on the freshly-cut surface than is the case with cold metal. Therefore, the ordinary machine for boring the inside of the cast, and in which a single knife is made to revolve slowly and take one heavy cut (Fig. 21), is less unsuitable than might at first

FIG. 21.

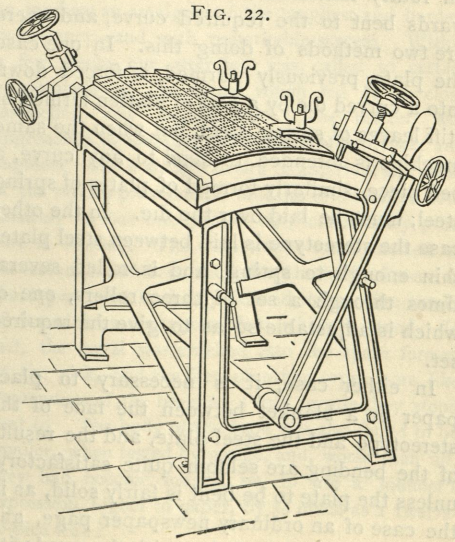


MACHINE FOR BORING THE INSIDE OF THE CURVED PLATE.

sight be supposed. But in this case, if a rapidly revolving cutter were used, and were fed with slightly soapy water by a series of conduits in the cutter-bar, it is quite likely some economy of time would be effected. Soap, like oil, soils the surface of the type-metal sufficiently to prevent welding.

A common form of apparatus for trimming and bevelling the edges of the curved stereotypes is that shown in Fig. 22, the plate

FIG. 22.

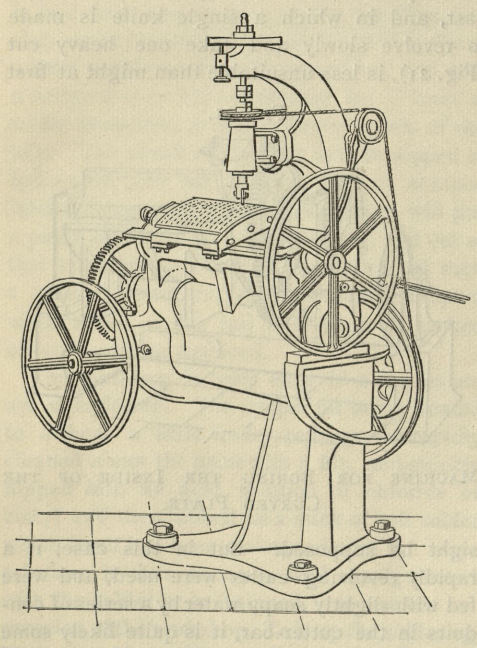


TRIMMING MACHINE FOR CURVED PLATES.

* Wood's fusible metal, referred to farther on, forms a still more fusible solder.

being clamped down on a suitable saddle, and trimmed by adjustable knives, the holders of which are moved backwards and forwards by hand. Another trimming machine is represented by Fig. 23. In this case we have a

FIG. 23.



TRIMMING MACHINE WITH REVOLVING CUTTER.

revolving cutter and the plate is fixed upon a saddle which traverses and rotates by hand gearing.

Occasionally plates intended for printing on rotary machines are cast flat, and afterwards bent to the required curve, and there are two methods of doing this. In one case the plate, previously warmed, is forced down into a curved die by a sort of platten formed of stiff leaves of spring steel, but when the same machine is intended to bend to any curve, a bed piece, similarly formed of plates of spring steel, must be laid over the die. In the other case the stereotype is laid between steel plates thin enough to spring, and is rolled several times through a set of three rollers, one of which is adjustable so as to give the required set.

In either case, it is necessary to place paper or a blanket between the face of the stereotype and the steel plate, and the results of the bending are seldom quite satisfactory, unless the plate to be bent is fairly solid, as in the case of an ordinary newspaper page, any extended whites interfering with the regularity of the bending. In the case of electrotypes, which are ordinarily backed up with a softer metal, the bending is easier, and electrotypes are often bent that they may be soldered into curved plates for illustrated newspaper work.

The work of the newspaper stereotyper is very seriously interfered with if any wood-mounted blocks are inserted in the forme he has to mould, the heat passing so much more slowly through wood than through metal as to make it almost a matter of certainty that the mould will be less dry where over such blocks; this being not only calculated to give a rough face to the lines, but also to lead to a distortion of the face of the mould in the second drying. This evil is especially apparent in the case of the zinc process blocks, which are made very thin, and are consequently mounted on an extra thick block of wood. The separate moulding of the blocks and casting type high, or the mounting of them upon solid metal bases, is so easy that there is scarcely an excuse for being so unfair to the workman as to send pages containing wood-mounted blocks when a stereotype is required in a minimum of time.

Probably the interfering influence of the wood mount is largely responsible for the tradition that the paper process is unsuited for the reproduction of the finest engraved work, but personally I am quite convinced that if all or most reasonable precautions* are taken to ensure the very best results, stereotypes can be made by the paper process, which are equal in fineness of surface and definition to the best electrotypes, and are superior in durability to many of the very thin shells of copper on a base of very soft metal, which pass now-a-days. In illustration of this I have on the table reproductions of fine engraved work, some of which I have done myself and others have been done for me by London stereotypers, a request for additional care having in almost every case had the desired result. Just before the lecture Mr. Dallas brought me this very finely stippled photo relief block—which you will admit is a crucial test object, and with it he brought me this paper-process stereotype made from it by Messrs. Sharrow and Anderson, and if you look

* Such as clean and evenly but slightly oiled original; well united, thoroughly seasoned, and rather dry flong; drying thoroughly in the press with occasional tightening up; long baking of the mould; non-use of French chalk; a suitable hard metal—say the tin alloy given on p. 13—and this at as high a temperature as the mould will bear; and a considerable "head" and margin of metal in casting, the margin being of the full thickness of the gauges.

at these carefully they will bear out what I have said. The paper process is, however, very ill adapted for moulding direct from wood cuts, owing to the action of the heat and moisture on the wood, and it is seldom employed for this purpose unless in the case of very small blocks, or when time necessitates it. The stereotype by the paper process is, when at its best, smooth, brilliant, and lustrous on the face, where the metal takes the impress of the compressed and hardened matrix, while the low parts, which are cast in contact with the spongy part of the mould, are always rough and often unsound in the sense of being permeated by holes and faults. The depths are nicely rounded and the square shoulders of the type-shanks show not at all, or only faintly.

I have spoken of the circumstance that in all ordinary stereotyping work some moisture remains in the mould, and I want to show you that it is possible to make a fairly sharp cast in a mould which is quite wet. This forme is warm, and I beat a piece of flong on it to make a mould, and I put the mould in the warm casting-box. You see all is now quite wet and warm, signs of vapour being visible at the mouth of the box. On pouring in Wood's fusible metal,* which melts considerably under the boiling point of water—say between 60° and 70° Centigrade—a very fairly good cast is obtained, the heat not having been sufficient to convert the water into steam. This experiment is interesting, not only as showing a possible means of making a stereotype in a shorter period than the usual time—although the high price of bismuth tends to put it outside practical work—but also as illustrating a point of some importance, that, in the case of a mould not very thoroughly dried, the best result is obtained with the metal at as low a temperature as practicable, whereas in the case of a mould baked for a long time, the hotter the metal is, the better the result, provided it just stops short of burning the paper; so it is possible to have failures either from the metal being too hot or too cold. The use of French chalk on the face of the mould tends to minimise the mischief resulting from traces of moisture in the mould, but as it invariably makes the face of the cast a little rough, it should only be used when needed. Another use of French chalk is when numerous casts are required from the same mould, as it tends to prevent adhesion between the cast and the mould. When a large number of casts are required from one mould, other precautions to be observed are to use a well-cemented and ripened flong which is not too soft, to avoid making the mould too deep, and to beat with numerous gentle blows, rather than with a smaller number of heavy blows, as this tends to give a mould in which the depths are nicely rounded off, and do not follow the nearly vertical sides of the type face. Again, patches of old mould, or pieces of thin sheet metal may be laid in the more considerable depths of the form, so as to support the flong where subject to the greatest strain. Some stereotypers do this in the case of most ordinary work; while those who have a difficulty in beating the flong without shifting it do the same in the case of all very open formes.

The question of damage to type during the process of stereotyping is one of some importance, and it mainly steps in when a high temperature is employed for drying. If the forme is very tightly locked up in the chase it may, in expanding and softening under the heat, become elongated, while on the other hand it may become shortened by the pressure of the drying-press. These two circumstances tend to make a newspaper fount become of unequal height, and the fount is rendered useless. In reference to this subject, Messrs. Caslon and Co. have sent me one of their circulars, dated April, 1880, from which I may quote the following :—

"A remarkable instance of the dire results of severe locking has lately come under our notice. A daily newspaper was supplied with founts, in the manufacture of which special pains had been taken to produce an amalgam of the toughest and hardest consistency—and with remarkable success. Within a few weeks our attention was called to certain appearances in the types which led to a close inspection and consultation. The matter was approached by founder, compositor, stereotyper, and engineer, with a sincere desire to ascertain the cause of the serious phenomena, and the evidence led conclusively to but one result—viz., unnecessary pressure in locking. The tremendous force exerted on the columns had been such that the back of some of the types bore, in clearly defined ridges, the marks of the nick on the type against which it stood. In fact, the metal was crushed into the space formed by the nick, and the feet of other types bore like impressions of the bevel of a lead or rule they stood next to. The body of the type was also found to be smaller, when tested by gauge, and, worse than all, they had become longer, or, to use a founder's expression, higher to paper, by as much as a twelve-to-pica lead!

"There is no remedy for this evil after the mischief

* One part of cadmium, two parts of tin, four parts of lead, and seven parts of bismuth.

is once done; but there is a valuable practical lesson to be learned which all overseers of newspaper offices will do well to enforce. Let the formes be locked with only a moderate force, sufficient to secure safe lifting. With the enormous power at the operator's command, only a slight turn of the wrench produces enough pressure on the type to secure this end—which may be verified by experiment—and then we strongly advocate loosening the formes as soon as they are placed on the hot stereotyping bed, so as to allow for expansion. When possible, lifting the formes at all should be dispensed with: they should be imposed and then slid along on a continuous bed or imposing surface right on to the moulding bed, so as to avoid all possibility of accident. With such convenience at command there would be no necessity at all for excessively powerful locking apparatus, and the ordinary wooden quoin and side-stick would be found sufficient. .... We strongly advocate the insertion of wood furniture—say about two-line pica reglet—between the long side-stick and the type; for, in case of undue expansion of the type in the process of moulding for stereotyping, the wood would give way before the metal type, and the latter would therefore be preserved."

Since the date of the circular quoted, the typefounders have done much in the way of using harder metal for their types, but the precautions mentioned are still needed.

It is sometimes desirable to mould work, in case of a future demand; but this is not done so often as it might, because the printer does not care to take the trouble of sending the formes to the stereotyper. Now I want to show you how easy and inexpensive a thing it would be for any printer to mould his formes immediately they come from the machine, and to keep the moulds in case of future need. Here are the formes of a 16-page weekly publication, and a set of light metal frames fit in the gutters so as to bring these up to the level of the face of the type. These pieces of flong—each corresponding to a page, with the necessary margin—are rather over-dry than moist, and with them I mould a page at a time, and not many seconds are required for moulding each page, while as each mould is made it is lifted off and set aside. The formes have not even been washed, as the remaining ink does no harm in this case, and the moulds being removed at once, there would be but little risk of adhesion, even if there were not a trace of ink on the type. The damp moulds are now laid between quires of rough paper, this being sufficient to keep them flat during the time of drying, which may be several days. When dry they are stored away in bundles. In casting from one of these moulds a few pieces of old mould are pasted into the hollows at the back, and the brown paper flap is pasted as usual on that edge which is to be the top, but the extra thickness of brown paper at the back is dispensed with. In some newspaper offices it is the practice to take the moulds off some of the earlier pages while wet and dry them separately. When the mould is removed wet there is a contraction of about a one hundred and thirtieth linear.

More or less successful attempts have been made in the direction of moulding the type in a dry and spongy millboard and casting at once—these methods being called instantaneous stereotyping processes—much the same sort of thing as I showed you at the end of my previous lecture—but nothing of this sort has come into general use. The pressure required for a newspaper page would be enormous, and the results hitherto have not been quite satisfactory.

The paper process of stereotyping lends itself very well to the production of plates for printing in several colours, whether for typographic or block work; a series of plates cast in immediate succession, in the same well-dried mould, corresponding very exactly; and it is better to cut away from each plate those parts not wanted than to attempt to block them out in the mould, as this latter course may easily lead to distortion. In cutting away the waste metal from the plates, care must be taken not to strain or distort them, and for such a purpose the routing-out tool alluded to on p. 17 is very useful.

The mention of cutting away plates for printing in several colours recalls a use made of stereotypes early in this century by Charles Babbage. He would obtain a number of casts of a block showing a complex machine, and by cutting them away he would produce a separate block showing each important organ of the machine, and these would be printed alongside the complete sketch.

LECTURE III.—DELIVERED MARCH 3, 1890.

PLASTER PROCESS, ELECTROTYPES, CASTS IN STEEL, IRON, BRASS, AND OTHER REFRACTORY METALS, CELLULOID, RUBBER, AND GELATINOUS COMPOSITION, AUTO-STEREOTYPING, MISCELLANEOUS PROCESSES.

It is useless for me to attempt giving anything like such full working details of the numerous processes which have to be considered in this lecture as was the case when I spoke of the paper-mould process, as each would probably occupy as much time as was taken up last week with the paper process alone, and, even by trespassing on your patience as much as was then the case, some ten or fifteen lectures would be needed.

The invention of the plaster-mould process was spoken of in the first lecture, and in spite of the comparative slowness with which work is turned out, and the cumbrous nature of the appliances required, the plaster process survives, principally for casting from formes of music type. In this case it is specially adapted for the work, as so many of the music characters hang over the body or shank of the type, and these overhanging sorts would be very liable to injury in moulding by the paper process also in the drying-press: while the plaster mould has the advantage that imperfect joins in the lines of the music staff can be made good by carefully drawing a piece of metal rule along the lines in the mould.

When a forme is set with the view of being stereotyped by the plaster process, quadrats and spaces as high as the shanks of the type are often used, and, for the convenience of stereotyping, music founts are ordinarily furnished with high spaces and quadrats.

Narrow clumps are generally placed so as only just to surround the forme, and outside these we have the ordinary low furniture. The first thing is to rub a paste of plaster of Paris and water well into the interstices of the forme, this being done with the hand, and as the plaster sets the excess is brushed away with a stiffish brush, so as to leave the face of the type clear of plaster, the depths of the forme partly filled in, and the vertical sides of these depths sloped off with banks of plaster.

It is desirable to allow this "filling-in" to become dry before further treatment, and warmth may be employed to expedite the drying, after which the face of the type is finally cleaned by the brush, and any fragments of plaster which clog the faces of the letters must be picked out. The forme, being now clean and dry, is thoroughly oiled, enough oil being used to saturate the surface of the filling-in plaster, and although the type should be well oiled, the hollows on the face of such letters as *o* or *e*, should not be left full of oil. The low-priced thin mineral lubricating oil recommended in the case of the paper process is inconveniently thin, so it is better to use such an oil as cotton-seed oil, or rape-seed (colza) oil.

Some strips of thin sheet metal are now laid on the furniture, outside the narrow clumps,* and an iron frame about three-quarters of an inch deep is laid over, so as to enclose the forme with its clumps, when some plaster of Paris, mixed with water to the consistency of thick cream, is poured over the type, after which a brush is worked with an up and down motion in the plaster covering, so as to chase away air-bubbles, but this brush should not be drawn out of the plaster till the dabbing is finished, or fresh bubbles would be created. The frame is now filled with the mixed plaster, and as it begins to set, the top is scraped off level with a straight-edge. All the plaster should be of the same mixing, as if a stiffer plaster is used to fill up, there will probably be distortion in drying. Rather low-priced plaster

* Clumps are not essential in working the plaster process, but are desirable for several reasons.

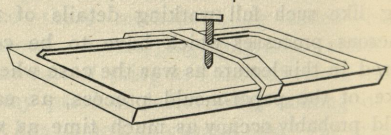
is often to be preferred for this purpose than the very finest quality, which commands its high price mainly on account of its whiteness, freedom from dark specks, and the fineness with which it is ground. It is of the utmost importance that the plaster used should have been freshly roasted, and at such a heat as to set quickly and firmly. The stereotyper can easily judge of these points for himself. Extremely fine grinding is no advantage, as the surface obtained is no better than with moderately fine grinding, while flatter and better casts are obtained in the latter case. As a rule, the plaster should be obtained direct from the maker, who will usually supply the smallest quantities if sent for; and generally the grade sold in London as "fine" is more suitable than "superfine" or "double-superfine." In mixing the plaster, a quantity of water is taken in a basin, and powdered plaster is added in a stream till it is judged that enough has been added. Before proceeding to mix with a spoon, it is well to see that the water has penetrated to the top of the blunt cone of the plaster, which at this stage will stand above the water level. In this case it is easy to mix the plaster without forming many air-bubbles, which would not be the case if the water were added to the plaster. Mixing-basin, brush, and spoon should be thoroughly washed immediately after use.

In ten minutes or a quarter of an hour the plaster mould should be set, and the cast can be removed, and for this purpose a tool like a miniature two-pronged crowbar is used, the opposite sides of the frame being gently prised up in succesion to the minutest appreciable extent, after which the frame, with its cast, can be lifted off; but any unwatchful application of force in this case will spoil the mould. The moulding-frame is always bevelled so that the plaster cast can readily be removed from the top, and the cast is now baked at a heat of from 200° to 210° Centigrade for about two hours, care being taken to so place it in the oven that the air can circulate as freely all round it as practicable—for example, on its side, or, better still, on a flat shelf formed of such heavy wire-netting as was previously referred to (p. 11, Lecture II).

Here is a mould already baked, and the essential point in casting from such a mould as this is to retain the melted metal in contact with it for a considerable time, say ten or twelve minutes, but it is quite easy to obtain a cast without the heavy and expensive plant ordinarily used. Over this gas-burner is a rectangular iron dish, and it is now heated to about the melting-point of type-metal. In it I place the plaster mould face downwards, the border of the mould having been cut away at two points so that metal can flow freely under it; and over the mould is fixed a bent iron plate, which will prevent it rising nearer to the top of the dish than an inch, when metal is poured in. Having now filled the iron dish with melted type-metal so that the plaster mould has floated up against the stop, I will leave the gas burning for about ten minutes, and if it is then extinguished we shall have a good cast as soon as all is cold.

In actual practice, the rim of the plaster cast is cut away at two or three points, and it is placed face downwards into an iron box, called a dipping-pan (Fig. 24), under the cast

FIG. 24.



THE DIPPING-PAN.

is a loosely-fitting iron plate. The cover of the dipping-pan is held in position by the iron strap and screw shown in the diagram, but this cover is cut away at the corners so that the metal can freely flow in. This dipping-pan is lowered into a pot of melted type-metal and kept there for ten or fifteen minutes, after which it is lifted out and cooled. The plaster cast floats up against the lid of the dipping-pan, while the floating plate rests against the rim of the plaster mould, thus gauging the thickness of the cast. Little need be said about the trimming and finishing of the cast except that, as the cast is not of an accurately gauged thickness, and, moreover, as the floating plate is rough—there would obviously be no advantage in surfacing or planing it—it becomes essential to trim or plane the back of the plate, and this is generally done by a special surfacing lathe. Although plaster expands at the moment of setting, it afterwards contracts in drying, and a plaster stereotype is therefore smaller than the original by about 1-80th linear.

Gypsum, the mineral which, when gently roasted, gives plaster of Paris, may be regarded as a compound of sulphate of lime (calcium sulphate) and water in the proportions indicated by the formula—

$$Ca\,SO_4 \,.\, 2\,H_2O.$$

The above formula corresponds to about 21 per cent. of water in the mineral, but when the gypsum is exposed to a heat ranging from 120° to 250° Centigrade, about three-fourths of the water represented by the above symbol is driven off, and the gypsum falls to a coarse powder, which then has approximately a composition expressed by the formula—

$$2\,Ca\,SO_4 \cdot H_2O.$$

This expression corresponds to about 6 per cent. of water, and if the plaster in the course of manufacture is heated above 250° Centigrade, and the retained water is reduced much below 6 per cent., the plaster will harden but slowly. In hardening, the sulphate of lime reunites with water, forming a compound which is probably identical, from a chemical point of view, with the original gypsum.

When the mould is baked at a temperature of about 200° or 210° Centigrade, the greater part of the water is driven off, and the mould retains the 6 per cent. or so which is contained in ordinary plaster, but during the long contact with the fused type metal, at a temperature of about 320° or 330°, almost the whole of the remainder is driven off, and a sound cast is not obtained until this is the case. The reason why the thick plaster cast is not baked in the first place at a temperature above the melting point of the metal, and a cast obtained by simple pouring in of metal, is the extreme friability of the completely dehydrated mould.

Messrs. Sharrow and Anderson, who work the plaster process in London, and turn out about 200 music pages a day by this method, have been good enough to send me a set of specimens showing the various stages—the forme and moulding-frame, rough cast and dipping-pan, and also a finished plate.

A modification of the plaster process exists, in which the friability of the completely dehydrated plaster mould is overcome by the expedient of making the mould of extreme thinness, and in close contact with an iron plate; indeed, the mould is so thin that the face of the cast is virtually made on the surface of the iron; the plaster in this case adhering to the iron in patches and ridges, forming reverses to the depths of the original. A wood-cut consisting of a close mass of fine lines, without large patches of white, or a grained photo-tint block in which there are no considerable depths, can be easily reproduced by a method of this kind, as the mould adherent to the iron plate consists of very small and thin deposits of plaster which have not much tendency to scale off, and which can be completely dehydrated by exposure for a short time—even a few minutes—to a heat about equal to that of melted type-metal. Sometimes the iron plate is studded with small holes, tapering larger toward the back, so as to give a better hold to the plaster, but this device is especially needed when such an original as a forme of type is moulded from, and the reliefs of plaster are more considerable. A method of this kind may, in some cases, compete for rapidity with the paper process.

In working by this method, the original—after being "filled in" with plaster, if necessary, and oiled—is smeared over with a thin layer of mixed plaster, and the iron plate to be used (this may be one plate of the casting-box used for the paper process) is similarly smeared over with plaster, but, naturally, the iron must not be oiled—indeed it may be advantageously rubbed over with white of egg to promote adhesion. The two plastered surfaces being now pressed together with considerable force, ten or fifteen minutes are allowed for the plaster to set, after which all that excess of plaster which exudes from the sides is trimmed off, the mould on the iron plate is dried at about 320° Centigrade, and the cast is made by backing up the mould with another iron plate (or the other leaf of the casting-box), and pouring in metal as when operating by the paper method. A modification of this mode of working can be used in making reproductions of medals by casting in plaster moulds, two plates of iron, the register between them being insured by steady-pins, forming the framework of the mould; the mould being then made by spreading a little plaster on each iron surface, and compressing the original between them. The original must not only be slightly oiled, but must be inserted in a hole cut of the right size in a sheet of oiled paper, otherwise the two parts of the mould would not separate.

The electrotyping process is very extensively employed in making stereotypes* of engravings, or of letter-press matter containing engravings, and when the original wood is to be moulded, the electrotype method is perhaps the most desirable process of

* Among the London craftsmen the words stereotype and electrotype—or rather "stereo" and "electro" are used as distinguishing terms—and the former term is so exclusively applied to the stereotype in type-metal, that to speak of an electrotype cast as a "stereotype" is regarded as a barbarism.

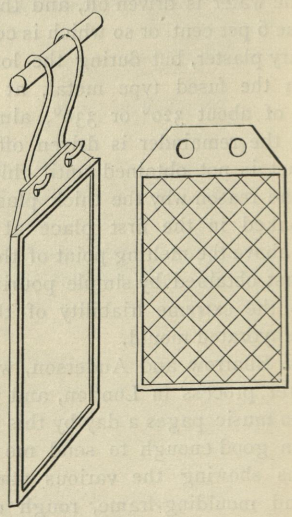
stereotyping, as no moisture or heat is used in moulding; and in spite of what I said about the best possible stereotype by the paper method being equal to the best electrotype, the average commercial electrotype of the present day is very much better, as regards surface and definition, than the average commercial stereotype by the paper process.

If an electric current is passed through a solution of copper sulphate (blue-stone or blue vitriol), so that the current passes from one copper plate immersed in the solution to another copper plate also immersed in the solution, one of these copper plates will become thicker from the deposition of copper, while the other plate becomes thinner by the dissolving away of just so much copper as was deposited upon the first. In this case, although the solution of sulphate of copper is doubtless decomposed and reformed during the action, it is there at the end; and for our present purpose we may regard the change as a mere transference of copper from one plate to the other, the deposition taking place on that copper plate connected with the zinc plate of the electric battery, and the dissolving away taking place in the case of that plate connected with the other pole of the battery, which may be a silver plate, a platinum plate, or a carbon plate. This action you can see going on before you, not only with a battery, but also with two forms of dynamo machine used as the source of the electric current; and if I replace one of those copper plates, upon which more metal is being deposited; by a wax mould of typographic matter well brushed over with black lead, the copper is deposited on this mould, and in time there will be a compact film of copper covering the mould. This film when thickened up by a layer of type metal forms the ordinary electrotype used by the printer.

In the room is a very complete set of specimens illustrating the various stages of the ordinary process of electrotyping, these having been lent by Messrs. Richardson, Koolman, and Isger; and the shortness of time at my disposal must make me content with showing you these, rather than demonstrating every stage of the process. There are also some illus trations sent by Messrs. F. Plummer and Co.

The forme from which a stereotypic cast is to be made by the electrotype process should be surrounded with type-high clumps, and be filled in with plaster of Paris, as in the case of a forme for reproduction by the ordinary plaster method; then the face of the forme should be thoroughly brushed over with powdered black lead. All is now ready for moulding in a bed of wax. It is desirable to use genuine beeswax (unbleached), and to soften it by adding to it about one-seventh of the turpentine sold as "Venice" turpentine; and when these materials are melted, it is usual to stir in a little (say one-thirtieth) of finely-powdered plumbago (black lead). The wax mixture having been melted in a jacketed steam pan or water bath, and well stirred, it is allowed to settle for a second or two, and a strip of paper is drawn along the surface to bring any air-bubbles to one side, when the wax mixture is ladled out into shallow pans, about one-third of an inch deep, and cast of soft type-metal, called moulding-pans (Fig. 25), these being laid out

FIG. 25.



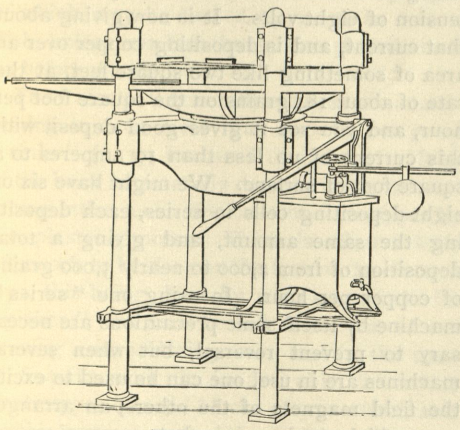
MOULDING-PANS.

on a level slab. It is well for the pans to be very slightly warm when filled, and they should be filled so that the wax stands well up to or a little over the edges. As a rule the wax does not crack in cooling unless it has been adulterated with the so-called Japan wax, but one remedy in this case is to add a little more of the turpentine. Unless there is gross clumsiness in filling the moulding-pans, nothing more than a few isolated air bubbles will be formed, and these can be readily broken by touching with a pointed iron rod, which may well be warmed so as not to chill the wax. The wax, when set, should, like the forme, be well blackleaded with finely-powdered

blacklead, a soft, long-haired brush being used in its application. The moulding must not take place until the wax has thoroughly cooled, as, if this were done, the internal portion, being softer, would very likely exude; but the wax plates, when once cooled, may advantageously be kept ready for use in a warm place rather than a very cold place.

For moulding from the type, a rather lightly-built hydraulic press, made something like Fig. 26, is used, the only notable features

FIG. 26.



HYDRAULIC PRESS FOR MAKING THE WAX MOULD.

besides lightness of build being the shortness of the rise, and a slab of iron on the bed, which can be pulled out drawer-fashion. The forme being placed on the draw-slab of the press in such a position that it shall come fairly over the ram, the blackleaded slab of wax is laid over it, and sufficient pressure is applied to mould all the details. In removing the mould from the forme, the same sort of care is required as when removing the plaster mould from the type, and when removed there will always be some superfluous wax to trim off. The parts of the mould corresponding to the more extended whites will probably require building up with wax, so that the electrotype shall have sufficient depth, and perhaps the simplest way of doing this is to hold a pointed pencil of iron or copper (building iron) in the right hand, and having warmed the metal rod, a slender stick of wax is held against it, so that a slow and steady stream of melted wax flows from its point. A watchful person can soon learn to lead this stream to the required places, and can raise the wax close to the borders of cavities in the mould, without fear of filling them. Several "building irons" of assorted size should be provided, and if a minute gas jet plays on the tool, a little way from the tip, time will be saved; the gas being led through the hollow stem of the "iron" by an indiarubber pipe about one-sixteenth of an inch in diameter. For "raising" the mould between fine lines, an ordinary pen may be mounted in this way, the small gas jet playing on its back, and dips can be taken, ink fashion, from a pot of melted wax. A building pen, capable of holding more wax, and suitable for coarser work, may be made out of a piece of copper-wire cable, the wires being cut away at various points, so as to make a conical termination ending in two wires only, which form the working point, and the tool will be more lasting if each cut-off end is brazed down in its place with a minute patch of spelter or silver solder.

The wax must now be thoroughly blackleaded by beating and rubbing finely-powdered black lead on to the face of the mould, either by hand or by a machine, until every part is covered, after which the back and sides of the moulding-pan are painted over with melted wax to render the surface non-conducting, and all is ready for the depositing bath. Very much depends upon the nature of the blacklead (plumbago, graphite) employed to make the surface of the mould conducting, and the electrotyper is often so much impressed by the desire to obtain a "perfectly pure" article or something of the "very finest quality," that he pays quite extravagant prices to those who profess to supply such. Blacklead, which is a form of the element carbon, is a mineral, and is always accompanied by traces of impurities, such as iron or earthy matters, and although samples containing much earthy matter are less desirable than those containing a small proportion, the point at issue is mainly one of structure. Blacklead ranges from hard crystalline scales to almost an amorphous mass, and neither one extreme nor the other is most suitable, but the kind best for our purpose is one which in grinding will break up into very minute and *thin* scales, a quality which can be recognised by a microscope examination, but a practical test is best for the electrotyper. A moulding-pan having been filled with wax and cooled, a plate of thin sheet metal, having a slot about a quarter of an inch wide in it, is laid stencil fashion across from edge to edge, and is held firmly in position while one of the samples to be examined is brushed through the slot for a certain number of minutes. The

stencil having been shifted, other samples, perhaps to the number of twenty or thirty, are similarly brushed on the slab of wax, after which it is put in the depositing bath and connected to the source of current, when the rapidity and perfection of the covering on the various strips will give nearly all the information wanted, although before finally deciding, the three or four samples which come out best should be tested on an actual mould having rather deep and narrow lines. In this case the quarter-inch test strips would be no use, and a very good way is to cut out a metal or card templet which will leave, say, a fourth of the mould uncovered for each sample. A suitable blacklead is often made worse by platinising or gilding, and a blacklead most suitable for a soft mould is not always the most suitable for a hard mould.

Not only have many other materials than wax been used in typographic electrotyping, but gutta-percha is now very often used in France; also there are other ways of moulding. These matters I would much like to discuss at length, but time does not permit. I may, however, refer to Mr. Clay's convenient method of moulding, by which the "filling-in" of the forme with plaster is avoided. A piece of stout linen is laid on the forme, and over this a sheet of india-rubber, after which the moulding-pan is placed in position and pressure applied; in this way a general impression is obtained, and a second pressure without the linen and india-rubber sheet gives a moulding of the sharp face of the forme. The essential point is to ensure exact register in placing the mould in position the second time, a very easy matter if the chase and moulding-pan are provided with corresponding pins and holes. By using a soft wax, a mould of moderate size can be made by this method with an ordinary printing press, or a screw-press.

In the depositing bath a simple solution of sulphate of copper, nearly saturated, is all that is wanted, and although London electrotypers in many cases still use the Smee battery, a series-wound dynamo, driven by a steam-engine, is, under ordinary circumstances, a much more economical source of electricity; but the special circumstance that favours the survival of the battery is the facility it offers for depositing during the night, when it would be an additional expense to keep the engine running; but even in this case secondary batteries charged by a dynamo during the day would probably be more economical.

Here is a small Siemens' series-wound lighting dynamo (D 6), a kind of machine which would in many cases be better suited to the needs of an establishment for typographic electrotyping than are some of the specially-made depositing machines, which are primarily intended for operations in which much heavier deposits are required, and this machine, while consuming only about a quarter of a horse-power, and running quite slowly, will give a current of about 20 amperes with a tension of eight volts. It is now giving about that current, and is depositing copper over an area of something like two square feet, at the rate of about 184 grains on the square foot per hour, and you see it gives good deposit with this current of no less than 10 amperes to a square foot of surface. We might have six or eight depositing cells in series, each depositing the same amount, and giving a total deposition of from 2,000 to nearly 3,000 grains of copper per hour. In using one "series" machine by itself some precautions are necessary to prevent reversal, but when several machines are in use, one can be used to excite the field magnets of the others, an arrangement which conduces much to convenience of working, and is, moreover, suitable for the charging of secondary batteries.

When a sufficient thickness of copper (say 1-30th to 1-40th of an inch) has been deposited upon the wax mould, hot water is poured on the back of the copper electrotype (called the "shell") to disengage it from the wax mould, and the rough back of the shell is "tinned" with a coarse solder consisting of equal weights of tin and lead, such coarse solder having less tendency to run through any holes in the shell than would be the case with a solder having a full proportion of tin. This alloy is usually granulated by being poured through wire gauze net into water, and it should be quickly dried, otherwise some oxidation will take place. The shell having been trimmed to the outside of the clump marks, is laid face downwards in a shallow iron pan (backing-pan), which can be heated either by being supported on the surface of a bath of melted backing-metal (generally made rather soft; lead 16 to 18 parts, antimony 1 part, a little tin—say three-fourths of a part—being added, unless the lead used is known to contain tin), or by a gas burner. If the shell tends to curl, it is easy to keep it tolerably flat by laying iron bars on the level edges left by

the clumps, and the clean back of the shell is now brushed over with the acid chloride of zinc solution (*see* foot-note p. 18, Lecture II.), and sprinkled with the granulated solder, a final brush over with the solution being given if the solder does not spread to all parts immediately. The backing-pan may now be removed from the source of heat, and before the solder has time to set, melted backing-metal is poured on in a steady stream commencing in the middle and travelling outwards as a spiral, so as to build up a thickness of at least a pica all over the shell,* the clump edges of which may be turned up so as to form a dish, unless iron bars have been placed round as before mentioned.

The "electro" generally requires some hammering upon a level iron slab to bring up "sinks" (p. 17, Lecture II.), and the levelling of the back is generally done by a special surfacing lathe, as in the case of stereotypes by the plaster process. There is often a little afterwork to be done on the face of the electrotype, this being done by a workman called a "picker," who must be deft in the use of engraving and soldering tools, and in the case of fine-cut work it is desirable to mount electrotypes on solid blocks of type-metal, and for this purpose one of the fusible solders referred to in the last lecture may be used (p. 18); the top of the block and the bottom of the "electro" being both well amalgamated with the solder, then brought into close and solid contact while sufficiently heated. A sort of cold soldering is sometimes employed, the two surfaces being separately amalgamated with mercury, and then held in close contact by a press till the excess of the mercury has diffused into the mass.†

The casting of stereotypes in brass (the material used for the earliest stereotypes on record) and in other refractory metals, has not yet become general, although the extensive present use of rotary and other machines for printing and branding directly upon wood is likely to create a demand for iron and perhaps steel stereotypes.

Iron or brass casts can be readily made in sand or loam moulds, but in moulding it is so much more convenient to mould from an ordinary stereotype than from the type forme, that I have no hesitation in very confidently recommending this course. As moulding frames, two ordinary printers' chases may be used, one having register pins fitting into corresponding holes in the other, and both being furnished with a few cross wires to support the sand; but a gap should be cut away from the top of one to form an ingate. One part of Stourbridge clay and two of Bath-brick dust forms a very good mixture, and after this has been slightly damped, well rammed, and carefully levelled into the casting-box, the pattern stereotype is oiled and is forced by a press into the soft surface. A little brick-dust being sifted on to serve as a parting material,* the second chase is placed in position and filled with the moulding mixture, after which the frames are separated, the pattern removed, and the mould is baked. For casting, the two frames may be conveniently clamped up in the ordinary stereotype casting-box (Fig. 4, p. 12), a few channels being cut for the escape of air. The mould should be well dried, but not too rapidly, or it is rather liable to lose its face by a kind of granulation or scaling, and the metal should not be so hot as to cause "sand burning." On the table are moulds and casts which I have made to illustrate this method of working, and Mr. Peter Barry has been good enough to send me some very excellent casts which he has made. Stereotypes in high steel might perhaps be made by casting in moulds of lime compressed dry, and I have obtained promising results by this method, but should such be required they could, I think, be made, even if of considerable size, by the "striking" method indicated in Lecture I. (p. 3).

I find that by using a piece of wet asbestos millboard as a material for making the mould, we can stereotype in brass or iron by a method quite comparable to the ordinary paper-mould process, and I will illustrate this to you by making a cast in brass.

When the asbestos millboard, which may be about an eighth of an inch thick, has been wetted, it is pressed against the forme by means of a screw-press (there is no need to

* The French electrotypers always place gauges on the clump marks when pouring on the backing-metal, and just as it is on the point of solidifying, the platen of a press is brought down on it. In this way, the need of planing the back is often obviated, and the tendency to sinks and irregularities of the face is diminished. Of course when the above course is taken, the tinned shell must be placed on an accurately-planed surface. The French method is better adapted for rather thick than thin shells.

† As a means of fastening types together to form solid stamps (stereotypes in the sense in which Didot first used the word), the mercurial method of soldering is admirable, and it is also fairly satisfactory for fixing a letter into a stereotype plate, provided that the fit is accurate.

* As the pattern is generally forced in so as to be level with the surface of the mould, a sheet of oiled paper may be laid over instead of using parting sand.

work from a previously made stereotype in this case), removed, dried at a heat bordering on dull redness, and with a similar piece of plain asbestos millboard clamped in the usual stereotype casting-box, a bent iron wire gauge being between them; the brass is then poured in at the top. In this case there is no need to warm the casting-box, the slow conducting quality of the asbestos preventing all chilling of the metal.

The body of a cast made in this way is rough, and generally somewhat unsound, being cast against the spongy body of the asbestos millboard, but the face, which is cast in contact with the hard and compressed portions of the mould, is sound and good.

To show you what can be done in the way of typographic brass-casting, Mr. Nettleton, of Barnsbury, has been good enough to send me samples of his cast brass type, both in the rough and finished; these, I understand, are cast in iron moulds.

The various photo-stereotype or photo-typographic methods do not come within the scope of the present lectures, but I have now the opportunity of showing you some Arabic printing types cast in matrices reproduced by photographic means from an impression taken from type of a larger size. In this case the reproduction was made for Messrs. Stephen Austin and Sons, of Hertford, by Mr. Alfred Dawson—so well known as a successful worker in photo-engraving methods, and I am told the cost was only a small fraction of what the expense would have been if punches had been cut. I also have placed upon the table reproductions which I made some years ago of some letters from a book printed by Sebastian Gryphius, of Lyons, in 1539, and alongside them are the matrices and body mould. In this instance each letter, cut out of a photo-type block, was set separately in a level plate of metal, at the required distance and a thick electrotype cast was made of the whole. This was strengthened by a backing of soft metal, and when cut up it formed the matrices.

Celluloid, as a material for stereotyping, has been proposed by Jeannin, who makes his mould by mixing the soft unfused oxide of lead known as massicot, into a stiff paste with glycerine, and if baked for about five minutes in contact with the forme, at about 120° Centigade, the mould becomes hard, and separates. The celluloid is then softened at about the same temperature, and forced into the mould.

The same kind of mould answers well for making stereotype casts in the so-called Spence's metal (sulphur slightly hardened), an excellent composition of this kind being the following:—

Sulphur	100 parts.
Finely powdered pumice stone	30 ,,
Native sulphide of antimony ..	4 ,,

It requires careful melting, as if over-heated the sulphur would pass into the viscous modification, and it should be well stirred before pouring.

The use of india-rubber stereotypes has not gone much beyond their employment as hand stamps. The mould in which the rubber is vulcanised is generally made of a mixture of plaster of Paris and French chalk, the forme being "filled-in" with soap, to insure easy separation. As only small casts are ordinarily made, it is convenient to mix the plaster and French chalk (equal parts of each answers very well) to a paste with water, and to spread this on a level surface, and to force the forme into it. At other times the bed of plaster is moulded on the type with two successive pressures, the first with a cloth covering, and the second without a cloth, these operations requiring a means of keeping register, and being similar to Mr. Clay's method of moulding in wax for electrotyping. If a large mould is required, nothing is better than M. Jeannin's composition of massicot and glycerine, while simple plaster of Paris answers very well, especially if after drying it is hardened by saturation with a solution of shellac in alcohol. The mould having been obtained, is dried and warmed, and some uncured rubber, mixed (by strong rollers) with about one-tenth its weight of sulphur,* is softened by a gentle heat, and forced into the mould, after which the whole is exposed to a heat of 140° to 150° Centigrade for about half an hour, during which time the sulphur reacts chemically on the rubber, and what is called vulcanisation results, the rubber no longer becoming plastic by heat. Hot-presses for the vulcanisation of rubber stamps are now sold at a moderate price, or a simple arrangement, which I showed in this room nine years ago, may be used. It consists of a cast-iron fish kettle, upon the bottom of which is cast a slab of type-metal an inch thick. Inside the kettle is placed a small press, like a copying press in miniature. By the side of the press stands a small iron cup, containing glycerine, and in this fluid is immersed the bulb of a thermo-

* Mixtures of this kind can be obtained where materials for making rubber stamps are sold.

meter, the stem of which projects through a hole in the cover of the kettle. By means of a small gas stove, heat can be supplied to the apparatus, and it is easy to so adjust the gas supply, that the thermometer shall indicate a tolerably constant temperature of, say, 140° or 150° Centigrade, the slab of metal serving as an equaliser of heat.

Mr. John Leighton introduced rubber stereotypes about 26 years ago, and his firm has been good enough to send here samples illustrative of their manufacture and use, a subject which in itself might well occupy a whole lecture. At one time experiments were made as to the practicability of using rubber stereotypes on rotary printing machines, as they would easily adapt themselves to the required curves, and might be expected to save power in the working of the machines. Fatty ink soon softens and destroys rubber stereotypes, so that an ink made by dissolving an aniline colour in glycerine is generally used. These will generally fade rather rapidly on exposure to the light, but by dissolving nitrate of silver in glycerine we have an ink which does the reverse. At first it gives a colourless impression, or nearly so, but on exposure to light it gradually becomes deep brown.

Elastic stamps, which may be used with the ordinary printer's ink, can readily be made of any required hardness with a gelatinous composition similar to that used for the ordinary printer's inking rollers. The making of these is a very simple matter indeed. A piece of very thin sheet lead, such as is sold for covering damp walls—say about an eightieth of an inch thick—is slightly oiled, laid over the forme, and beaten with the moulding-brush until a satisfactory impression is obtained, after which it is laid on a level flat surface, a border is placed round it, and a melted gelatinous mixture is poured over it; any mixture, such as is used for printers' roller composition, will serve, although something rather harder will often be required. By soaking a fine hard gelatine (Coignet's silver label gelatine, for example) in water till it has absorbed about its own weight of water, and then melting it with half as much glycerine, a serviceable hard composition is obtained, but with some tendency to shrink, which can be met by adding more glycerine, and heating for some time in a flat dish over boiling water, so as to evaporate some of the water.

Under the head of auto-stereotyping I propose to deal with a few of those methods, in which lines are cut out or indented on a level surface by some sort of sketching or writing action, this writing being then used as a mould in which is cast a stereotype, from which the writing or drawing may be printed, and of late years such methods have come much into use, and have acquired considerable importance.

If one simply takes a blunt style, and, while using some considerable pressure, with this makes a sketch on a very soft paper board* or a blotting-pad, a mould is obtained which, if cast from—as in the ordinary paper process of stereotyping—yields a block that can be rapidly deepened by the engraver, and may serve very well as an extemporaneous illustration for a newspaper; and as the material for this sort of thing is always at hand in a newspaper office, it is a very convenient method to employ when only a rough sketch is required; and by a very simple expedient, the labour of cutting away the whites of such a cast may be obviated, provided there is no objection to the sketch appearing on a ruled or cross-hatched ground. Before making the sketch, a hard impression of a lined, dotted, or cross-cut block is made on the paper pad,† and the sketch is afterwards made with the style. A cast now being taken, the ruling or dotting gives sufficient support on the whites, and the sketch shows as lines on the tinted ground.

The above is essentially a process for rough or hasty work of the crudest character, and we now pass on to one of the earliest methods, and perhaps the best of all, if perfection of result is considered, namely, the glyphographic process, invented by Edward Palmer‡ about 1841. A thin coating of wax, whitened by a suitable pigment (white lead or other heavy lead compounds answer best), is spread on a blackened copper plate,§ and the sketch is made on this with a point, so as to lay bare the black copper, the dark lines thus produced showing the artist the progress of his work. Any lettering may be done with stamps or types, the wax ground being softened by a little heat if necessary. The extended whites are now raised by the building process already described in reference to the wax mould for electrotyping, the hot pen there mentioned being used for filling in between the finer

* A thick "wood middle" or pulp-board answers well.

† An assemblage of ordinary brass "rules," plain, dotted, or waved, may be used.

‡ Palmer kept a well-known philosophical instrument shop in Newgate-street, and was succeeded by Horne and Thornthwaite.

§ The clean copper can be blackened by a weak solution of silver nitrate or platinum tetra-chloride.

lines, and during this process any false line may be covered; after which an electrotype cast is made from the wax mould. Binger, in his "Glyphographie," published at Amsterdam in 1850, gives as fine examples of work by this process as any since done. It is now very extensively employed, and it is understood to be substantially the method by which several well-known firms produce blocks. As it would be in many cases obviously inconvenient to submit the traced wax plate itself as a proof, a photograph is often sent.

There are several processes roughly classed as "clay" processes, in which a mineral mixture is used on the copper plate, and a cast is made directly in stereotype metal from the tracing made on this surface, and I will illustrate to you the form of this process which I have found to work best in my own hands.

I now take a plate of copper which has been roughened by glass paper, blackened by a solution of perchloride of platinum, rubbed over with white of egg, and then flooded with a white-wash composed as follows:—Stereotype paste, as given on p. 7, Lecture II., 6 oz.; whiting, 24 oz.; water, 3 pints. Enough should be allowed to remain on the plate to form a layer 1-20th to 1-30th of an inch thick, and the plate is then set in a horizontal position to dry. A design can be readily traced with a point through the friable ground, and after the mould has been dried at about 200° Centigrade, a cast is made in the casting-box ordinarily used for the paper process. Apart from the operation of deepening the whites of the block and the making of the sketch, the whole work can be performed in ten minutes or so. The mixture used for coating the plate may serve to "raise" the whites on the mould, this preparation being put on by means of a pipette, but such a course is not to be recommended, as it involves delay in drying, and there is increased chance of the coating leaving the copper. The most essential point is the use of albumen on the roughened plate, this enabling a friable mixture to hold on sufficiently for practical purposes.

Closely analogous to the autographic stereotyping methods are those in which a machine analogous to a type-writer is used to make a matrix, letter by letter, on such a material as flong, wood, or soft dry pulp boards, and in Guillot's "Graphitype" (Lecture I., p. 3) we have the parent of all such methods. The weak point in all these processes is the difficulty of making corrections or alterations, and no printing method which does not provide for this is likely to be generally accepted; the only matrix method which gives this facility in a high degree being the matrix-setting method of Herhan (Lecture I., p. 820), which method, if operated in connection with a type-setting machine, should be quite as rapid as the type-writer methods, and it allows alterations as readily as when ordinary types are used.

In these lectures much I should liked to have talked of has been necessarily omitted.

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